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THE VICTOR HUGO MONUMENT, DESIGNED BY BARRIAS AND ERECTED AT THE PLACE VICTOR HUGO, PARIS.

THE VICTOR HUGO CENTENARY.

WHEN it was first announced that the one hundredth anniversary of the birth of Victor Hugo was to be solemnly celebrated, no one dreamt that both the press and the people would join as unanimously as they have in paying tribute to one of the greatest of modern French poets and novelists.

The evident pains taken by the government authorities and by the commission to whom the regulation of all details had been intrusted, resulted in giving to the ceremonies all the *eclat* of a national festival. No vast amount of money was spent; only 80,000 francs had been appropriated by the Chambers as the state's contribution. The city of Paris, however, had assumed the responsibility of decorating the town and of fittingly conducting the ceremonies held at the Hotel de Ville.

A writer in L'Illustration states that much was done with the small amount of money at the disposal of the commission, but that still more could have been done, or at least that much could have been avoided that should not have occurred. To his mind, the most indulgent critic would be forced to confess that the decorations in various parts of the city, if not cheap, were at least very much inferior to what was expected. Without mentioning the Panthéon—the decorations of which were ridiculously *banale*, with their poor garlands of paper and their gingerbread crowns—the ornamentation of the Place Victor Hugo seemed that of a past festival, rather than of one still to come. But on the evening of the 26th of February, when the statue of Barrias stood out in the glare of the searchlights and the flower beds bloomed with electric lights, the Place assumed a truly festive aspect, which made one forget deficiencies so apparent in daytime.

The Place des Vosges was perhaps more happily decked out than any other part of the city. There it was that the school children brought palms and flowers and laid them at the pedestal of the statue.

The city of Paris had authorized the painter André Dévambez to design an invitation for those who were to witness the unveiling of the monument at the Place Victor Hugo. M. P. Avril designed the programme for the ceremonies held on the evening of February 27 at the Hotel de Ville, in honor of delegates from foreign countries and from the provinces.

For the 26th of February, which marked the one hundredth year of the centenary, an elaborate programme had been prepared. At ten o'clock in the morning the government officials paid their tribute to the poet at the Panthéon. At three o'clock in the afternoon the monument at the Place Victor Hugo became the scene of the festivities. In the evening, at the Comédie Française, Victor Hugo's "Burgraves" was performed.

The events of the morning, at the Panthéon, were stamped with cold official pomp. All the official bodies of the state, the Senate and the Chambre des Deputés, the representatives of the navy, army, Institute, University and Judiciary were gathered in the immense temple, around the bust of the poet. From a huge tribune the President himself presided at the ceremonies, surrounded by all the Ministers. Speeches were made by M. Leygues, Minister of Public Instruction, in the name of the government, and by M. Hanotaux, in the name of the Academy. Madame Bartet, of the Comédie Française, recited Victor Hugo's "Contemplations: O souvenirs, printemps, aurore!" Madame Segond-Weber declaimed "Stella." M. Mounet-Sully with a magnificent lyric outburst read the "Hymne," written in commemoration of those who died for their country. The music for the occasion was furnished by an orchestra and by the chorus of the Conservatoire. First the Marseillaise was sung and played; then came Saint-Saens' "Hymne à Victor Hugo," composed for the occasion. Following the discourse of M. Hanotaux came the "Hymne à la France" of Berlioz. The "Chanson d'Ancêtre," sung by M. Delmas, and the "Chant du Depart" completed the programme.

At the ceremonies at the Place Victor Hugo, held under the auspices of the municipality, a crowd of all sorts and conditions had gathered. Contrary to custom, the monument had not been covered with the traditional veil. Under a lowering sky, the brazen figures of the monument gleamed almost joyously. Paul Meurice, Victor Hugo's old friend, was the first to speak. To him Paris owes the monument and the posthumous honor to Hugo.

At the Théatre Français in the evening the most fitting homage was paid to Hugo. Mmes. Bartet and Segond-Weber recited verses of the poet.

THE STRATIFICATIONS OF HYDROGEN.*

By SIR WILLIAM CROOKES, F.R.S.

THE following pages give the outcome of attempts to prepare pure hydrogen, and experiments on the stratifications exhibited by the purified gas under the influence of an induction current. The researches were commenced in 1884, and have been continued intermittently to the present time.

The original apparatus consisted of a vacuum tube of soda-glass, 6 inches long and ½ inch wide, having sealed-in aluminium terminals at each end. The pole at one end was ring-shaped, at the other pointed. The vacuum tube was connected to the mercury pump at one end, a tightly-packed phosphoric anhyride tube intervening. At the other end was another phosphoric anhydride tube, a hydrogen generator of zinc and dilute sulphuric acid, and a tap to control the flow of gas. The hydrogen was passed through the apparatus for some hours, and the whole was exhausted to a high point, refilled, and again exhausted. This was repeated many times; but, on exhausting to the stratification-point, I could get no spectrum which did not show, in addition to hydrogen, also mercury.

The apparatus was therefore modified. Strips of palladium foil were charged with hydrogen by the electrolysis of dilute sulphuric acid, a 4-cell Grove's battery being used for one hour. After drying, the palladium strips were put in a glass tube, and sealed between the generator and vacuum tube. At first, crude gas from the generator was used to wash out the apparatus, and after many fillings and exhaustions —the last of the highest possible point—the generator and tap were sealed off, leaving only the palladium and drying tubes attached to the apparatus. A portion of the palladium was now gently heated; the gage sank 12 centimeters, when it was again well exhausted and a little more hydrogen liberated. This was repeated three times, when the tube was exhausted to the stratification-point—about 4 millimeters.

PARTI-COLORED STRATIFICATIONS.

The strata were twelve in number, and of a slightly concavo-convex button-shape, each of a blue color on the convex side facing the negative pole, and pink on the other side. On reversing the current, the buttons faced round, always presenting the blue face to the negative pole. Examination with a spectroscope showed strong hydrogen lines in the pink parts, and both hydrogen and mercury in the blue parts. Fig. 1 shows the appearance at this stage.

The exhaustion was now raised to 2 millimeters, when the whole of the blue faces of the parti-colored buttons suddenly migrated to one bright blue, well-formed button, nearest the negative pole, all the other buttons remaining pink. The appearance is shown in Fig. 2. Round the negative pole an indistinct halo showed both mercury and hydrogen; but on the blue button mercury only was detected, not a trace of even the brightest hydrogen line being there seen. On the pink portions the hydrogen lines were in excess, but mercury could be seen all along the tube.*

At 1 millimeter pressure very little hydrogen could be detected by the spectroscope, the stratifications had almost disappeared, and mercury was strong throughout the tube.

ELIMINATION OF MERCURY VAPOR.

The mercury apparently diffused into the tube from the pump and many devices were adopted to keep it out. Long glass tubes filled with purified sulphur broken into coarse pieces were partially successful, but something (probably sulphur) was communicated to the hydrogen which interfered with the purity of the colors. Also the sulphur did not prevent a little mercury diffusing in if the tubes were left on the pump all night.

Experience showed that mercury was very difficult to eliminate from a tube once it had gained access. It adheres to the walls of the tube, and defies detection in the cold, but becomes visible in the spectroscope as soon as the tube is heated by a lamp. Therefore a new hydrogen tube was made, and connected with tubes containing sulphur, bright copper turnings, and phosphoric anhydride; the copper intervening to keep out the sulphur. Here, again, mercury was detected after some days, but only in minute traces. In each of these cases occurred the phenomena of the pink and blue strata at one exhaustion, changing to all-pink with a concentration of the blue to the front on increasing the vacuum; the single blue button showing the mercury spectrum. Continued pumping diminished the hydrogen, but apparently did not affect the mercury to the same extent. It appears that the great diffusibility of the hydrogen causes it to be readily pumped out, while the mercury is continually being replenished by diffusion from the pump.

A slight difference is produced in the purity of the colors of the strata according as aluminium or platinum poles are used. A pair of vacuum tubes was made, one having the usual shaped aluminium poles, the other having platinum poles of a special construction. Each terminal was of double wire, at one terminal bent into the form of a ring, and at the other a straight pole. The ends of the wires forming the poles were sealed through the tube close together but not touching, and terminated in loops outside, so that they could be raised to red or white heat by connecting them with a few battery cells. The arrangement will be readily understood by reference to the accompanying drawings (Fig. 3). Thus heat could easily be applied during exhaustion, first to one pole and then to the other, even while the induction spark was passing. At first much gas was liberated from the platinum, but by repeated heating, pumping, and passing the spark, all the occluded gas was abstracted, and then the fillings with hydrogen and subsequent operations were commenced.

The general plan of the apparatus is shown in the drawing (Fig. 4). At the end furthest from the pump is the hydrogen generator, *A*, consisting of a U-shaped tube filled with dilute sulphuric acid, having in one leg a plate of amalgamated zinc, *B*, and in the other a sheet of platinum, *C*. Both the platinum and the zinc are connected metallically to platinum wires sealed through the glass. A funnel with a stopper, *D*, sealed to the outer limb of the generator admits dilute acid when required. A tap, *E*, on the other limb enables the reservoir of hydrogen to be disconnected from the rest of the apparatus. Following this tap is a battery of three tubes, one, *F*, containing small lumps of dry caustic potash; the second, *G*, and the third, *H*, tubes containing phosphoric anhydride. Between the second phosphoric anhydride and the vacuum tube is another tube having sealed onto it, comb-like, seven projecting arms, *J J*, each containing a strip of palladium foil saturated with hydrogen.

The vacuum tube, *K*, is 8 inches between the terminals and ¾ inch diameter; it comes next to the comb, and then between it and the pump is a battery of tubes, each twelve inches long, to keep out the mercury. The first tube, *L*, is divided by a constriction in the middle, and contains, in the half next the vacuum tube, bright metallic copper, in the other half sulphur. The three next tubes, *M, M, M*, contain sulphur, but in the middle of each are placed a few grains of iodine separated from contact with the sulphur by a plug of asbestos on each side. The sulphur is prepared by keeping it fused at a temperature a little below its boiling-point till bubbles cease to come off, so as to get rid of water and hydrogen compounds. It is then allowed to cool, and is pounded and sifted so as to get it in the form of granules, averaging a millimeter in diameter. Ignited asbestos is packed at each end of the tubes to keep the contents from blowing out when the vacuum is proceeding, or air is suddenly let in.* Next follows a tube, *N, N*, constricted in the middle, containing in the first half phosphoric anhydride, and in the second finely powdered dry caustic potash. A tap, *O*, connects the apparatus with the pump to prevent diffusion of mercury when the pump is not in use. All parts of the apparatus were built up in place and sealed together with the blowpipe. The glass was new, and the apparatus had been kept apart from mercury until it was sealed together.

The apparatus was exhausted from air, the tap, *E*, being closed and *D* open. Electrolysis was then commenced (*D* being closed), and the tap, *E*, was slightly turned until the escape of hydrogen into the apparatus was equal to the speed of its generation. The apparatus was filled, and several times exhausted, until no improvement in the spectrum or stratifications could be seen. The electrolytic cell was then sealed off at a narrow constriction between the first potash tube, *F*, and the phosphoric anhydride tube, *G*. After good exhaustion one of the branch tubes of palladium was heated, when the gage sank several centimeters. Exhaustion and refilling from fresh palladium were repeated until no alteration was detected in the appearance of the strata. Then, for the first time, I ob-

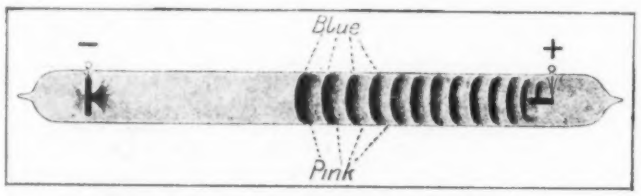


FIG. 1.—PARTI-COLORED STRATIFICATIONS.

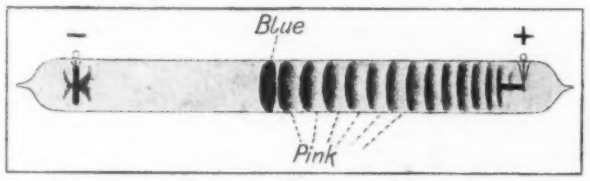


FIG. 2.—HUES AFTER RAISING EXHAUSTION 2 MM.

*A paper read before the Royal Society, February 6, 1902.

*I have been unable to find any reference to this concentration of the blue constituents of the strata into one single button at the end near the negative pole. In the classical researches of Messrs. De la Rue and H. W. Müller on the "Electric Discharge with the Chloride of Silver Battery," numerous references are made to the blue and pink parti-colored character of the strata, and also to the change of color from all blue to all pink which follows a change in the electrical conditions. Thus we read: "Thirty-nine strata, the convex side being blue and the broader concave side reddish." "Twenty-one strata, very blue on the convex face, pink on the concave."—Phil. Trans., vol. clxix., p. 175.

Sometimes the stratifications are described as all of one color: "Twenty-one very blue strata." "The strata were blue, and sixty-one in number." "Showing twenty-one double strata, intensely blue, but with a carmine line between the components."—Phil. Trans., vol. clxix., pp. 175, 190.

Frequently a change from all of one color to all of the other color is recorded. Thus: "The tube was filled to within 1 inch of the negative with strata; all these were blue, but they turned pink when 200,000 ohms resistance was introduced. When 7,590,000 ohms resistance was introduced, a very close and somewhat agitated pink stratification was produced." "Thirty-four steady blue strata were produced; on introducing 200,000 ohms resistance, the strata turned pink." "With 3,600 cells the strata were blue and sixty-one in number. With 700,000 ohms resistance the strata were reduced to eighteen and turned pink." "A change of current frequently produces an entire change in the color of the strata. For example, in a hydrogen tube, from a cobalt-blue to a pink."—Phil. Trans., vol. clxix., pp. 183, 190, 231.

Very few spectrum observations were made by the authors, and they are not very definite in character. One tube, which gave ten luminosities, was examined with the spectroscope. "The C and F lines were brilliantly seen in the glow around the negative terminal, but were not visible in the spectrum of the nebulosities, notwithstanding that they were brighter than the negative glow; there were blue, green, and red visible, but not the characteristic green and red lines of hydrogen." In another tube, "The characteristic hydrogen lines were very brilliant when the spectroscope was directed to the glow around the negative terminal, but quite a different spectrum was seen on a bright stratum, with mercury lines in the orange." "The hydrogen lines could not be seen either in the strata or the glow on the negative ring, but instead of them mercury lines came out strongly. There is reason to think that at this stage there was little gas except mercury vapor in the tube." "A change of current frequently . . . changes the spectrum of the strata; moreover, the spectra of the illuminated terminals and the strata differ."—Phil. Trans., vol. clxix., pp. 180, 216, 232.

*An apparatus of this kind was briefly described by the author in a paper read before the Royal Society in 1885 ("Radiant Matter Spectroscopy—Part II., Samarium," Phil Trans., vol. clxxvi., p. 693, June 18, 1885). The apparatus was used to prevent mercury from getting into the small radiant matter tubes employed in the research.

tained hydrogen strata showing no blue, either throughout the tube or concentrated in front, while the most careful examination showed no mercury. The stratifications were all pink, and showed the hydrogen lines strongly.

Many disadvantages were noticed in the apparatus just described, the chief being the danger of introducing more impurities than were kept out by the copper, sulphur, and iodine tubes. The palladium method of introducing hydrogen was not altogether satisfactory, as only small quantities could be dealt with, and occasionally at a critical point the store was exhausted. Also, the electrolytic generator of hydrogen was too small. It was decided, therefore, to devise and fit up an entirely new piece of apparatus. In this another method was used for keeping out the mercury. It had been noticed that the diffusion of mercury from the pump proceeded the more slowly as the distance from the pump and the narrowness of the connecting tubes increased. It was thought that by introducing a long narrow spiral between the pump and the apparatus, one complicated system of tubes, with their attendant dangers, could be removed; the result showed this supposition to be correct. Two vacuum tubes were employed, one having aluminium, the other platinum terminals. The hydrogen generators were increased in size and number, and were so distributed that they could be sealed off one after the other during the progress of the experiment.

STRATIFICATIONS IN PURE HYDROGEN.

The arrangement of the apparatus is shown in Fig. 5. The three hydrogen generators are called Nos. 1, 2 and 3. In No. 1, the gas is generated by the action of hydrochloric acid on zinc. This crude hydrogen is only used to drive out the air from the rest of the apparatus, and to remove the air dissolved in the liquids. When it had done its work, the generator was sealed off between Nos. 1 and 2, at *A*. It was considered that having the apparatus to begin with full of even somewhat impure hydrogen was better than starting with it full of air. The second and third generators contain at the bottom a pasty amalgam of mercury and zinc forming one pole, and a piece of platinum forming the other pole; the electrolyte is dilute hydrochloric acid. Platinum wires sealed through the sides of No. 3 carry the current from three Grove's cells to the interior. After the apparatus has had generator No. 1 removed, a large quantity of hydrogen is passed through from the second generator, with the object of replacing the impure hydrogen by some of a purer quality. When No. 2 is exhausted, it also is sealed off at *B*, leaving only the third generator with its drying tubes connected with the apparatus. Before sealing off No. 2, filling and exhausting is carried on until the hydrogen shows no impurity when spectroscopically examined in a capillary tube attached to the vacuum tube. The gas from the first and second generators bubbles first through strong caustic soda, *C, C, C*, to remove any acid carried over from the generators, then through strong sulphuric acid, *D*, to take away the bulk of the moisture, and thus save the drying tubes; it then passes through the purifying arrangements more especially connected with the third generator. Having sealed off Nos. 1 and 2, gas is evolved from No. 3 generator. Hence it passes through strong sulphuric acid in the tube, *H*; then over a tube filled with granulated caustic soda, *F*; and next through a tube, *G*, tightly packed with phosphoric anhydride. *H* and *I* are two taps, having a reservoir, *K*, between them. When full of gas, *H* and *I* are closed, and the tubes, *L* and *M*, after having been exhausted to a high point, can then be fed with limited amounts of pure dry hydrogen by slightly opening tap, *I*, and closing it when equilibrium is restored between *L, M* and *K*. *N* is a spiral of narrow glass tubing immersed in a beaker of ice and water. At *O* is a tap to keep mercury from diffusing into the pump if the apparatus has to be left all night. The vacuum tube, *L*, is provided with aluminium poles, and the tube, *M*, has the platinum poles made double for heating purposes, as shown in Fig. 3.

Hydrogen from the first generator was passed through the apparatus for two hours, when it was sealed off. The whole apparatus was exhausted to a high point, and No. 2 generator was set to work. Hydrogen was passed several times at full pressure through the apparatus for one or two hours, and then exhausted to the stratification point. During these operations the platinum terminals of one of the vacuum tubes were heated to full redness, and the current was kept on both tubes for some hours to drive off occluded gases.

Finally the second generator was sealed off, and hydrogen used from the remaining generator. After much washing out with hydrogen at the ordinary pressure, exhaustion and refilling were continued, and finally the reservoir, *K*, was filled; both taps, *H* and *I*, being closed. The tubes were highly exhausted to the non-conducting point, and tap, *I*, opened and then closed, so as to introduce a little nitrogen. *H* was then opened and again closed, so as to equalize the pressure in *I*, and exhaustion proceeded to the stratification point. At first the strata were irregularly colored with a suspicion of blue on one face, but as the operations just described were continued, the blue faces disappeared, the stratifications assumed a pure pink blue, and showed the hydrogen spectrum alone; no mercury was detected in any part of either tube.

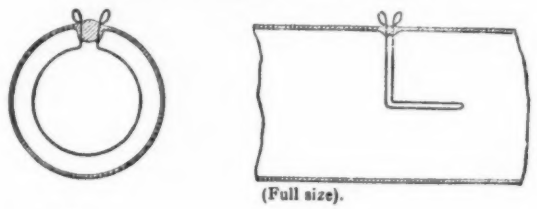
From the first to the eighth filling the strata were pink from the trace of slaty blue color on the faces next the negative pole. From the tenth filling the blue faces disappeared, and after the twentieth filling no trace of blue could be seen, and the spectrum of hydrogen alone was visible.

On examining the spectra of the stratified gas in the two tubes, each showed strongly the line spectrum of hydrogen; but while the spectrum in the platinum-poled tube showed pure red, blue, and green lines on a black ground, that in the aluminium-poled tube showed in addition the fainter hydrogen line spectrum in the yellow and orange. This result may be due to the greater surface exposed by the aluminium poles; it was not further examined.

Having at last succeeded in getting hydrogen free from mercury, experiments were instituted to verify the inference that the blue components of the blue and pink strata usually attributed to hydrogen were really due to the presence of a trace of mercury.

FIG. 6.—THE RESISTANCE.

FIG. 3.—WIRED VACUUM TUBES.



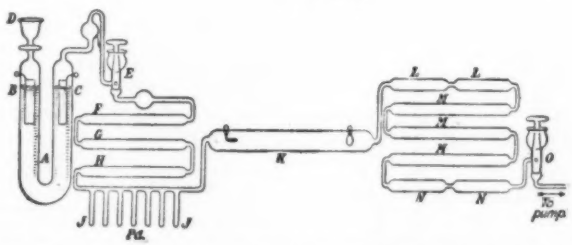


FIG. 4.—GENERAL PLAN OF APPARATUS FOR ELIMINATION OF MERCURY-VAPOR.

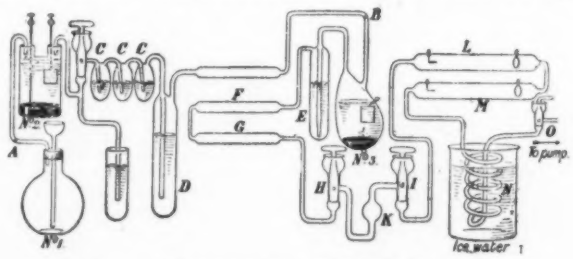


FIG. 5.—HYDROGEN APPARATUS.

ORIGIN OF THE BLUE COMPONENT OF PARTI-COLORED STRATIFICATIONS.

I used an apparatus similar to the last, but with only one generator. If my idea was correct, that the mercury in the course of a few hours diffused into the hydrogen tube from the pump when it was not at work, there ought to be an access of blue faces to the pink buttons after the exhausted apparatus had been at rest. After filling with hydrogen and exhausting several times, a hydrogen vacuum was obtained showing no blue faces to the pink strata. The apparatus was then left all night, and the stratifications examined next morning. The blue color to each face was now unmistakably visible. The refilling with hydrogen and exhausting was then continued. It was not possible in this way to get the tube entirely free from mercury, although it got less and less, as shown by the diminution of the blue faces.

Occasionally, when no mercury was present, a faint blue edging to some of the front pink strata was seen. This blue was too faint to show lines in its spectrum. After much searching the blue tint was traced to the phosphoric drying tubes. A clean tube was taken for stratifications, and sealed to the apparatus used in the last experiments. The whole was exhausted to a high point, and one of the phosphoric anhydride tubes was gently heated with a gas flame, the current kept going. Instantly a flood of blue light swept through the tube, and when concentrated in a narrow constriction the light showed a complicated spectrum which was not recognized; none of the characteristic lines of the phosphorus spectrum could be seen in it. The tube was cleared of the blue color by introducing hydrogen and pumping it out a few times, and then hydrogen was introduced and exhaustion continued to the stratification point. The strata now were pink with no appearance of blue. Warming the phosphoric anhydride tube at once reproduced the faint blue edging to the pink disks. This blue color was different both in tint and intensity to the blue color produced by mercury, but it was too faint to show a spectrum except in the constricted part.

It is of importance to ascertain whether the body producing this blue color can be removed from the phosphoric anhydride. The drying tube was again heated to the subliming point of the anhydride, hydrogen passed in, and the pump worked until the vacuum was almost non-conducting. The heating, passing in hydrogen, and pumping were several times repeated, the impurities diminishing each time. Ultimately a point was reached when, the tube being non-conducting, heating the phosphoric anhydride did not communicate any gas to the vacuum tube. At this stage the phosphoric anhydride still retained unimpaired its affinity for water. In any accurate experiment, therefore, the phosphoric anhydride tubes should have a preliminary heating in a vacuum to eliminate the impurity. This may be done with several tubes at a time, when they can be sealed at each end and preserved for future use.

It is thus seen that this blue glow is due to some impurity in the phosphoric anhydride. Likewise I have shown from the examination of its spectrum that it is not due to phosphorus. The glow probably is due to some intermediate oxide of phosphorus. In any accurate work with the mercury pump, where phosphoric anhydride is used as the drying agent, this source of impurity must not be overlooked.

An addition to the apparatus was made, a supplementary tube sealed on containing a grain of corrosive sublimate. This was used as being non-volatile at the ordinary temperature, but easily vaporized by heat. The experiment last described was continued, and immediately after the phosphoric blue edge appeared fresh hydrogen was let in and exhaustion continued till the faint blue was eliminated. The mercury salt was then heated, when immediately a rich blue edging appeared on the face of each pink stratification and the yellow lines of mercury shone out distinctly. Mercury blue is of a fuller color than that of the phosphoric blue.

ALTERING THE COLOR OF STRATIFICATIONS.

In the British Association reports for 1865 (Abstracts, p. 15), Mr. Gassiot describes the changes produced in the colors of the stratifications by introducing a water resistance in series with the vacuum tube. Having shown that the blue components of the stratifications are due to the presence of a trace of mercury with the hydrogen, experiments were commenced to ascertain what difference in the strength of the induced current would be necessary to alter the relative intensities of the pink and blue strata. Accordingly, I fitted up a resistance, shown in Fig. 6, consisting of a glass tube, *A, A*, 3 feet long and ¾ inch diameter, nearly filled with distilled water. Through a cork, *B*, at the upper end of the tube a copper wire, *C, C*, passes, and by raising or lowering the wire either the whole resistance of the water or any fraction of it can be thrown into the circuit. The upper part of the wire is connected with one pole of the coil and the water is connected with the other pole by means of a small platinum wire sealed through the bottom of the tube.

The wire was pushed down until it touched the platinum at the bottom, thus cutting out the water resistance. The strength of hammer-spring and the exhaustion were arranged to show good pink and blue disks. The wire was then gradually withdrawn, when the blue components gradually faded, and at a resistance of 6 inches of water the stratifications were all pink. Spectroscopic examination showed that in the parti-colored state mercury was strongly present in all

the blue components, together with the *C* hydrogen line, the mercury spectrum, however, being in excess. But when the water resistance was put in, and the buttons were all pink, mercury was still to be detected, but the hydrogen spectrum was more prominent. The green line of mercury was always the first to appear, and when the hydrogen became visible the first line to appear was the red.

That the change from parti-colored stratifications to all pink is occasioned by an alteration in the intensity of the spark, is also shown by the fact that altering the make and break of the coil produces the same change as putting in the water resistance. Screwing up the hammer-spring so as to induce strong magnetism in the core and high potential of spark, gives pink and blue parti-colored buttons. Weakening the spring, and thus weakening the magnetism, gives buttons which are all pink. I cannot, however, in this way cause the migration of the blue buttons to one single button in front. This phenomenon is produced only by an alteration of the exhaustion. Conversely, an alteration of the exhaustion will not change parti-colored buttons to buttons of all one color; this requires a change in electrical energy.

I consider the water resistance acts thus: At the same rarefaction, hydrogen conducts the current better than mercury vapor. With a strong induction-spark at a certain degree of exhaustion, the conducting power of the rarefied hydrogen is not sufficient to carry the whole of the current; some of it, therefore, is conducted through the mercury vapor, when the intensity of the blue drowns the feebler color of the hydrogen. When, however, a resistance of 6 inches of water (equal to about 500,000 ohms) is inserted, the current is so weakened that the hydrogen can carry the whole of it, and the blue of the mercury is not seen.

CONCLUSIONS; CHIEFLY THEORETICAL.

The phenomenon of blue faces on the pink disks is probably due to some such action as the following: At the exhaustion necessary to give stratification, there is a wide dark space round the negative pole. Here the negative electrons (Radiant Matter), issuing from the pole with enormous velocity, have sufficient energy to clear a space in front of them to a distance varying with the degree of exhaustion.

Dr. A. Schuster considers that the discharge through mercury vapor in a vacuum tube, when quite free from air, will not give rise to stratification, nor to the dark negative space (Dr. A. Schuster, "Experiments on the Discharge of Electricity through Gases," Roy. Soc. Proc., vol. xxxvii., p. 318). My own experiments (Journ. of the Inst. Electrical Engineers, vol. xx., p. 44) show that the dark space will form in pure mercury vapor. Whichever view may be correct, there is no doubt that if stratifications in mercury vapor are not altogether unknown, they are much more difficult to produce than similar phenomena in hydrogen or other diatomic gases. At a certain critical stage of the exhaustion, when both hydrogen and mercury are present, I obtain both mercury and hydrogen strata.

The following experiments appear to show that the presence of hydrogen* has a considerable influence on the behavior of mercury vapor in vacuum tubes. A tube with aluminium terminals had been attached to the pump for several days, and consequently mercury had diffused in and condensed on its sides. The tube was exhausted until, under the electric discharge, it phosphoresced of a brilliant green and was near the non-conducting point. It was heated very strongly with a Bunsen flame, when a faint pink luminosity was observed between the poles, the spectrum of mercury being absent. The tube was allowed to cool and a little hydrogen was introduced, when the usual pink stratifications appeared. On heating the tube to about the same temperature as before blue faces showed on the pink buttons, and the mercury spectrum was seen throughout the tube, especially in the neighborhood of the negative pole.

It is known that in a vacuum tube, at an exhaustion approaching the stratification point, any slight obstruction, such as constriction in the tube, or a series of wires sealed in, will cause luminous strata to hang round the obstruction. In a similar way, the hydrogen strata afford an anchorage, as it were, for the mercury, each hydrogen luminosity having a little blue glow of mercury hanging on to it; whereas, were there no hydrogen, no mercury stratification would be seen.

The pink and blue luminosities show where the electrons and gaseous atoms meet; when the speed of the electrons is suddenly diminished, the shock throws the atom into greater vibration, which, being communicated to the ether, produces vibrations of definite wave-lengths, constituting the special spectrum of the atom. The dense mercury atom is not driven back so much as the lighter hydrogen atom—hence the blue front to the pink buttons. A very little difference in the exhaustion suffices to break the adhesion between the mercury and the hydrogen; then the mercury vapor diffusing along the tube meets the electrons from the negative pole and is swept back to the head of the hydrogen strata, and becomes apparent as a single button of blue light.

RADIANT MATTER. ELECTRONS.

I have spoken of "Radiant Matter" and "Electrons" as if they were identical. Nearly twenty-five years ago I was led by experiments in highly rarefied tubes to assume the existence of matter in an ultra-gaseous state. Later, in a lecture delivered before the British Association at the Sheffield Meeting, 1879 (Chemical News, vol. xl., pp. 91, 104, 127), I first used the expression "Radiant Matter," or matter in the ultra-gaseous state, to explain the novel phenomena of phosphorescence, trajectory, shadows, mechanical action, magnetization, and intense heat. "In studying this fourth state of matter," I said, "we seem at length to have within our grasp and obedient to our control, the little indivisible particles which with good warrant are supposed to constitute the physical basis of the universe. We have seen that in some of its properties radiant matter is as material as this table, while in other properties it almost assumes the character of radiant energy. We have actually touched the borderland where matter and force seem to merge into one another" (Chemical News, vol. xl., p. 130).

In twenty-five years one's theories may change, although the facts on which they are based remain immovable. What I then called "Radiant Matter" now passes as "Electrons," a term coined by Dr. Johnstone Stoney, to represent the separate units of electricity, which is as atomic as matter. What was puzzling and unexplained on the "Radiant Matter" theory is now precise and luminous on the "Electron" theory. Thus my early hypotheses fall into order by the substitution of one expression for the other. A chemical ion consists of a material nucleus or atom of matter constituting by far the larger portion of the mass, and a few electrons or atoms of electricity. The electrons are the same as the "satellites" of Lord Kelvin and the "corpuscles" or "particles" of J. J. Thomson.

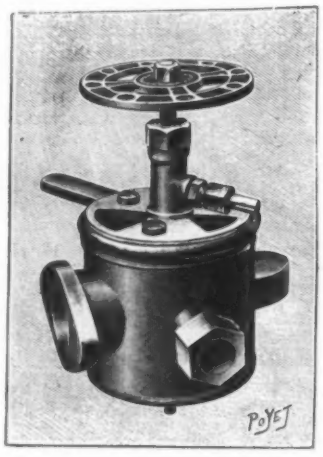
Electrons probably leave the negative pole with a velocity nearly uniform, modified to a considerable extent by the degree of exhaustion, and to a less extent by the electromotive force behind them. Many experiments—the details I must leave to a future occasion—show that the liberated electrons do not behave as a gas, i. e., they have not properties dependent on intercollisions, mean free path, etc.; they act more like a fog or mist, are mobile, and carried about by a current of air to which they give temporary conducting powers, clinging to positively electrified bodies and thereby losing mobility, and settling on the walls of the containing vessel if left quiet.

On the other hand, the crowd of hydrogen or mercury atoms, by virtue of molecular motion and intercollisions, act as gases. While their mean free paths are conditioned by the degree of exhaustion, there may be among them a certain number of actual free paths differing widely on each side of the mean. Under the influence of the electromotive force, and at the right degree of exhaustion, these atoms arrange themselves in groups (see Note A), while the rushing swarm of electrons driven from the negative pole meet them and render them visible. According to J. J. Thomson the mass of an electron is about the 1-700th part of that of the hydrogen atom, and as these masses start from the negative pole in a vacuum tube with a velocity of the order of half that of light, it is easy to see that their heating, phosphorescent, and mechanical power must be stupendous.

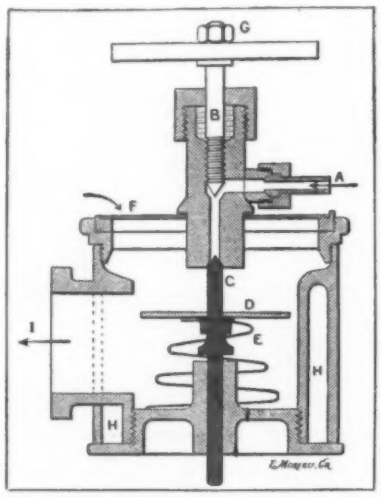
The basis of the Electron, as I foreshadowed in 1879 in the case of Radiant Matter, is probably the same in all cases—the Protyle from which the chemical atoms were assumed to be formed (Report of the Fifty-sixth Meeting of the British Association, Birmingham, 1886, p. 568, Address to the Chemical Section).

On the two-fluid theory, the electrons constitute free negative electricity, and the rest of the chemical atom is charged positively, although a free positive electron is not known. It seems to me simpler to use the original one-fluid theory of Franklin, and to say that the electron is the atom or unit of electricity (see Note B). Then a so-called negatively charged chemical atom is one having a surplus of electrons, the number depending on the valency, while a positively charged atom is one having a deficiency of electrons. Differences of electrical charge may thus be likened to debits and credits in one's banking account, the electrons acting as current coin of the realm.

*Possibly another gas would do as well. Hydrogen was used because in this instance the hydrogen generator was attached to the tube.



GENERAL VIEW OF THE QUEREY CARBURETER.



INTERNAL SECTION.

NOTES.

A. In an Address delivered before the Institution of Electrical Engineers, January 15, 1891, I gave an outline of a theory of stratifications in rarefied gases. The following quotation renders my meaning clear: "If, in any much frequented street, at some time when the stream of traffic runs almost equally in both directions, we take our stand at a window from which we can overlook the passing crowd, we shall notice that the throng on the footway is not uniformly distributed, but is made up of knots—we might almost say blocks—interrupted by spaces which are comparatively open. We may easily conceive in what manner these knots or groups are formed; some few persons walking rather more slowly than the average rate slightly retard the movements of others, whether traveling in the same or in an opposite direction. Thus a temporary obstruction is created. The passengers behind catch up to the block and increase it, and those in front, passing on unchecked at their former rate, leave a comparatively vacant space. If a crowd is moving all in the same direction, the formation of these groups becomes more distinct. Hence mere differences in speed suffice to resolve a multitude of passengers into alternating gaps and knots. Instead of observing moving men and women, suppose we experiment on little particles of some substance, such as sand. If we mix the particles with water in a horizontal tube and set them in rhythmical agitation, we shall see very similar results, the powder sorting itself with regularity into alternate heaps and blank spaces. If we pass to yet more minute substances, we observe the behavior of the molecules of a rarefied gas when submitted to an induction current. The molecules here are free, of course, from any caprice, and simply follow the law I seek to illustrate, and though originally in a state of rampant disorder, yet under the influence of the electric rhythm, they arrange themselves into well-defined groups or stratifications."—Journ. of the Inst. Elect. Engineers, vol. xx., p. 10.

B. "The theory of definite electrolytical or electrochemical action appears to me to touch immediately upon the *absolute quantity* of electricity or electric power belonging to different bodies. . . . And when comes the fact that the electricity which we appear to be capable of loosening from its habitation for a while, and conveying from place to place, *while it retains its chemical force*, can be measured out, and being so measured, is found to be *as definite in its action* as any of *those portions* which, remaining associated with the particles of matter, give them their *chemical relation;* we seem to have found the link which connects the proportion of that we have evolved to the proportion of that belonging to the particles in their natural state."—Faraday's "Experimental Researches in Electricity," par. 852.

"The equivalent weights of bodies are simply those quantities of them which contain equal quantities of electricity; . . . it being the ELECTRICITY which *determines* the equivalent number, *because* it determines the combining force. Or, if we adopt the atomic theory or phraseology, then the atoms of bodies which are equivalents to each other in their ordinary chemical action have equal quantities of electricity naturally associated with them."—Ibid., par. 869.

"In former investigations of the action of electricity it was shown . . . that the quantity of electric power transferred onward was in proportion to, and was definite for, a given quantity of matter moving as anion or cation onward in the electrolytic line of action; and there was strong reason to believe that each of the particles of matter then dealt with, had associated with it a definite amount of electrical force, constituting its force of chemical affinity."—Ibid., par. 1707.

(In all the above quotations the italics and capitals are Faraday's).

"It is therefore extremely natural to suppose that . . . every molecule of the cation is charged with a certain fixed quantity of positive electricity, which is the same for the molecules of all cations, and that every molecule of the anion is charged with an equal quantity of negative electricity."—Clerk Maxwell's "Treatise on Electricity and Magnetism," first edition, vol. i., 1873, p. 308.

"This definite quantity of electricity we shall call the molecular charge. If it were known, it would be the most natural unit of electricity."—Ibid., p. 311.

"Suppose . . . we call this constant molecular charge, for convenience in description, *one molecule of electricity*."—Ibid., p. 312. (Italics are Maxwell's.)

"Nature presents us with a single definite quantity of electricity. . . . For each chemical bond which is ruptured within an electrolyte a certain quantity of electricity traverses the electrolyte, which is the same in all cases."—G. Johnstone Stoney, "On the Physical Units of Nature," British Association Meeting, 1874, Section A; Phil. Mag., May, 1881.

"The same definite quantity of either positive or negative electricity moves always with each univalent ion, or with every unit of affinity of a multivalent ion."—Helmholtz, Faraday Lecture, 1881.

"Every monad atom has associated with it a certain definite quantity of electricity; every dyad has twice this quantity associated with it; every triad three times as much, and so on."—O. Lodge, "On Electrolysis," British Association Report, 1885.

A NEW CARBURETER.

THE accompanying figures, from La Nature, illustrate a new carbureter devised by M. A. Querey. The apparatus is formed of a vertical cylinder, at the upper part of which is a screw, *B*, that is operated by a handwheel, *G*. Upon the side there is a tube, *A*, through which the gasoline passes in greater or less quantity into the cylinder according to the position of the regulating screw, *B*. At the lower part of the cylinder there is a valve, *C*, that rests upon the piece, *D*, which is held firmly in place by means of a spring, *E*. At *F* is placed a sheet of wire gauze through which passes the external air that enters the cylinder and mixes with the gasoline vapor that makes its exit

at *C*. The explosive mixture is sucked in and makes its exit at *I* in order to reach the cylinders of the motor.

The chambers, *H H*, around the cylinder form a heater into which pass the exhaust products before making their exit. This heater is useful only in winter.

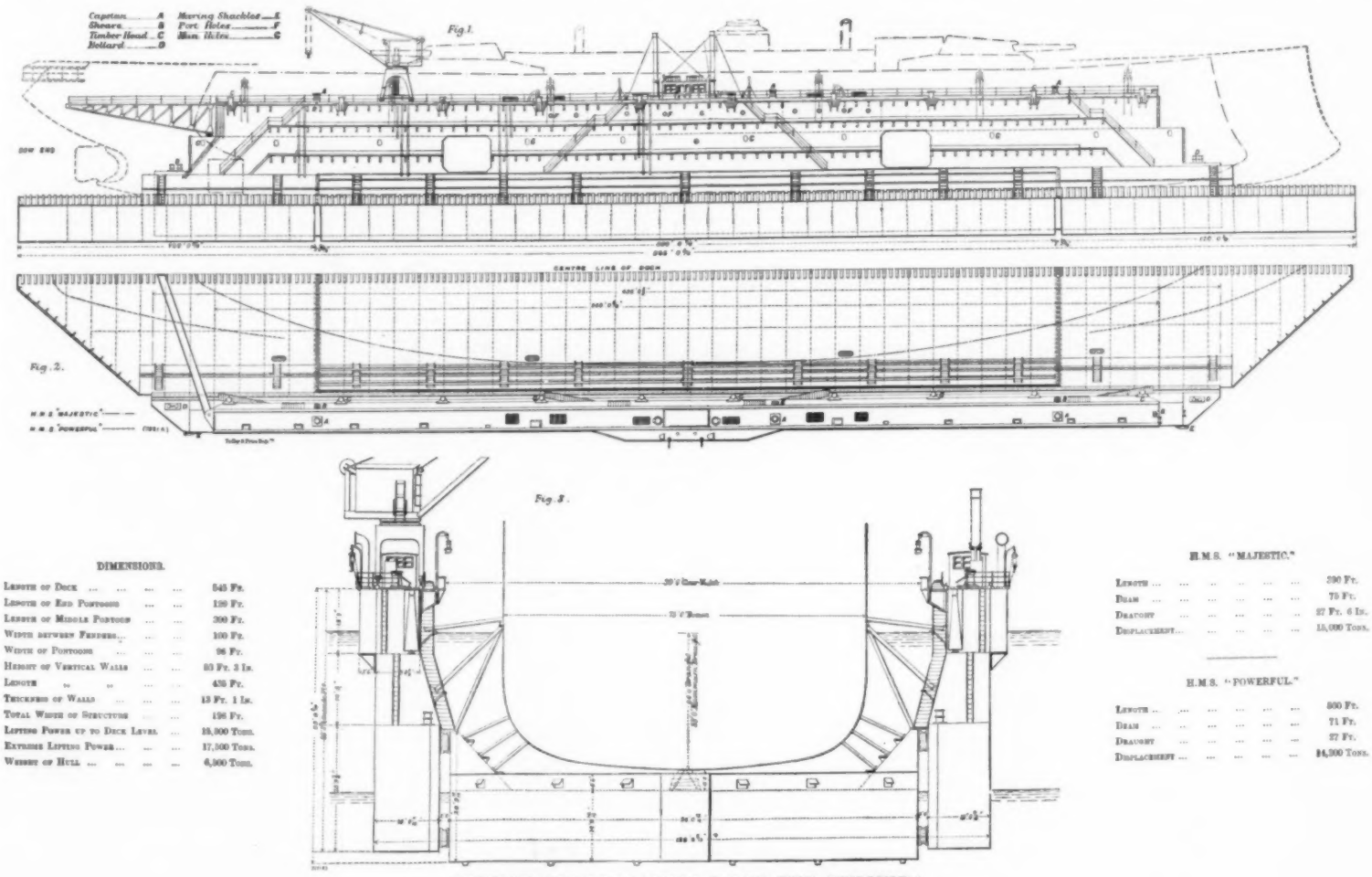
The operation of the apparatus is as follows: The motor upon which it is placed sucks in a quantity of air determined by its volume and the opening of the admission valve. To such quantity of air is added a quantity of gasoline regulated by the screw, *B*. The air becomes carbureted at once and forms a homogeneous product.

The operation of the apparatus is in nowise interfered with by the aqueous vapor contained in the air, even in great quantity, as on a rainy day. A motor provided with such a carbureter disengages neither odor nor smoke. The apparatus is strongly constructed and appears to be of a nature capable of rendering services to automobilists and to manufactories that use gasoline motors.

THE NEW BERMUDA FLOATING DOCK.

ON Saturday, February 8, there was launched from the yard of Messrs. C. S. Swan & Hunter, at Wallsend-on-Tyne, a floating dock which has been constructed for the government to the designs of Messrs. Clark & Standfield. This, we believe, is the longest and heaviest floating graving dock yet constructed, exceeding in these respects even the large dock of the United States navy, situated at New Orleans, and completed last year.

The new Bermuda dock is 545 feet long, and its clear width between rubber-fenders is 100 feet. As the side



DIMENSIONS.

LENGTH OF DOCK	545 FT.
LENGTH OF END PONTOONS	120 FT.
LENGTH OF MIDDLE PONTOON	300 FT.
WIDTH BETWEEN FENDERS	100 FT.
WIDTH OF PONTOONS	96 FT.
HEIGHT OF VERTICAL WALLS	53 FT. 3 IN.
LENGTH " "	435 FT.
THICKNESS OF WALLS	13 FT. 1 IN.
TOTAL WIDTH OF STRUCTURE	126 FT.
LIFTING POWER UP TO DECK LEVEL ...	15,500 TONS.
EXTREME LIFTING POWER	17,500 TONS.
WEIGHT OF HULL	6,500 TONS.

H.M.S. "MAJESTIC."

LENGTH	390 FT.
BEAM	75 FT.
DRAUGHT	27 FT. 6 IN.
DISPLACEMENT	15,000 TONS.

H.M.S. "POWERFUL."

LENGTH	500 FT.
BEAM	71 FT.
DRAUGHT	27 FT.
DISPLACEMENT	14,500 TONS.

BRITISH SELF-FLOATING DOCK FOR BERMUDA.

walls are a little over 13 feet across, the total width of the structure is somewhat above 125 feet. The lifting power, up to the pontoon deck level, is 15,500 tons, and by using the shallow pound this can be increased to 17,500 tons. The weight of hull is 6,500 tons. The sides or walls are high enough to enable a vessel of 32 feet draft to be berthed on the keel blocks, the latter being 3 feet 6 inches high. The whole structure consists mainly of five parts, comprising three pontoons and two side walls. The pontoons form the bottom of the dock, and are placed between the side walls; the latter extending almost as low down as to the bottom plating of the pontoons. This arrangement gives advantage of the full depth of girder, thus affording a maximum of longitudinal strength. The pontoons supply the chief part of the lifting power, and though the side walls may be used to some extent for the same purpose, their primary object is to give the structure stability, and to afford control over the dock in sinking it to take the ship on board.

It will be of interest to compare this dock with the one it is to displace at Bermuda. The old dock is 381 feet over all, and 84 feet wide between the side walls. Its normal lifting power is 8,000 tons; somewhat above the displacement (7,550 tons) of the "Bellerophon," which was the typical central battery ship of her day. By the use of end gates, however, the capacity of the dock could be brought up to over 10,000 tons, but this reduced the available length to 330 feet. The "Bellerophon" is 300 feet long and 56 feet wide; but the heavier fully-rigged, broadside, armored ships of the period—the "Agincourt" and the "Minotaur"—were 400 feet long and 59 feet 5 inches wide. Our recent battleships are 405 feet long and 75 feet 6 inches wide—a fact which illustrates the advances made in the size of war vessels during the period that has elapsed since the first dock was sent out. The cruiser class shows even more marked increase in dimensions; indeed, it may be said that 36 years ago we had nothing in the navy corresponding to our present first-class cruisers.

In the illustration we have shown by dotted lines the positions that would be occupied respectively by the battleship "Majestic" and the first-class cruiser "Powerful." The "Majestic" has a length of 390 feet, is 75 feet wide, and her displacement is 15,000 tons. In order to give high maneuvering powers, in the way of quick turning, to war-vessels, they are generally designed so that the ends are a good deal cut away, or, as it is described, with the deadwood removed. This cambering of the keel is a comparatively modern innovation, and it affects the berthing of a ship to some extent. Thus the length of bearing keel of the "Magnificent" is 343 feet; while in the "Terrible" it is but 40 feet more, although the big cruiser is 500 feet long. On the other hand, the "Campania," which, as an auxiliary cruiser, might have to be dealt with in war time, although 600 feet long, has a bearing on her keel of 545 feet.

Fortunately, modern vessels built of steel will submit to being supported out of water with very long lengths overhanging fore and aft. Perhaps the most notable instance on record is that of the mail steamer "Empress of China." This vessel injured one of her propeller shafts, so that it had to be withdrawn from outboard. She was at Barrow, where there is a floating dock only 242 feet long, the "Empress of China" being 455 feet in length between perpendiculars. There was thus an overhang of 213 feet to be divided between the two ends. In spite of this, the vessel was lifted sufficiently to withdraw the shaft and replace it, although the dock, which is of the depositing type, had not sufficient displacement to get the keel out of water. Perhaps another remarkable feat of ship-lifting may be mentioned here. In this the difficulty was with the opposite dimension—beam. The Russian so-called "circular ironclads," the "Popoffkas," have—at least the largest of them have—120 feet beam, but these vessels have been lifted on floating docks. In this case, however, the form of dock is of the L type—that is to say, it has only one wall. The Russian dock, which is at Sebastopol, has, however, been arranged by her designers, Messrs. Clark & Standfield, for taking very wide structures, the pontoons being capable of being extended out from the wall in a very ingenious manner. While mentioning this fact, it is, perhaps, as well to add that L docks, as ordinarily built, will take ships rather wider than the pontoons; for instance, the Barrow depositing dock has lifted paddle steamers of 68 feet beam, although it is but 54 feet wide. Naturally the strength of the dock itself has to be considered, as well as that of the ship; especially when heavy ships have to be lifted that have considerable camber. In the case of the Bermuda dock this feature has received special attention in view of the fact that she has to make an extended ocean voyage, in the course of which heavy weather may be met.

The vertical side walls of the new dock being 53 feet 3 inches high, give great depth of girder; but it is, of course, necessary that they should be firmly attached to the pontoon bottom. This brings forward another characteristic feature of these floating docks. It is required that their under-water parts should be examined for purposes of painting or repair, and they are therefore made "self-docking"—that is to say, any of the sections into which the whole structure is divided may be detached and lifted by the rest of the dock. Thus the middle length, 300 feet long, of the pontoon floor could be cast adrift and the rest of the structure sunk until the detached part, floating on the surface of the water, is brought level with a position high up on the walls, to which it would be attached. By pumping out the water that had been admitted to sink the structure, the middle length would be raised and its under part would be accessible. It will be seen, therefore, that the connections of the five main component parts of the dock have to be adjustable. The side walls are attached to the pontoons by double fish-plates and tapered pins, to take which there are steel lugs built into the structure, both of the walls and the pontoons. It will be readily understood that in a dock designed to make a trip across the Atlantic this part of the construction has received special attention. The designers have, however, experience to go upon, not only in regard to the old Bermuda dock, but with some others; among which may be mentioned the Stettin dock, built for the Vulcan Company, and the Havana dock, both constructed by Messrs. Swan & Hunter, to the designs of Messrs. Clark & Standfield, and both of over 10,000 tons lifting power.

The pontoons are, as stated, three in number. In the plan the divisions between them are plainly shown. The end pontoons are each 120 feet long, and have each 71 feet of the length rectangular in plan, the remaining part being beveled off in a way that will facilitate towing. The sides of the rectangular part of the pontoons are built up so as to form a broad altar standing 12 feet above the deck. The side walls are each 435 feet long, and, as stated, 53 feet 3 inches high. From their bases up to the altar level the width is 13 feet 2 inches, but they slope back to the level of the engine deck, where they are 9 feet 1 inch through. In order to give sufficient space for the boilers the sides are sponsoned out, thus forming a chamber which is 12 feet 6 inches wide. There are, as shown, two large openings in each of the side walls. These are for the purpose of admitting light and air under the bottom of a vessel when docked. In some docks they also serve as gangway openings when the structure is attached to the shore by brows. The ends of the side walls are beveled off to carry out the lines of end pontoons in order not to afford obstruction when the dock is being towed.

The three pontoons are divided in forty pumping divisions, and of these thirty-two are water-tight. The side walls have also eight water-tight compartments in each. All these divisions are provided with a separate pipe, each with a valve. All the pipes on each side lead directly into the main drain of its respective side. There are four 18-inch centrifugal pumps in each wall. The drains are continuous over the whole length of the walls, and as the pumps are seated directly on them, any one pump can empty all the compartments of its half of the dock. There is a central bulkhead dividing the dock into two halves, but this is not quite water-tight, small leakage holes being purposely left. If, therefore, the whole of the pumping machinery on one side were to break down, the other half could still empty the dock, though at a somewhat slow pace. The pumps are driven each by a separate compound condensing engine directly attached. A return-tube boiler supplies each pair of pumping engines with steam; but the connections are so made that the supply

of steam from any boiler is interchangeable. It will be seen, therefore, that in each wall the pumping arrangements are in duplicate, and that either wall can singly pump out the dock so as to lift it; though, naturally, the progress would be slower in the event of extensive breakdown.

The working of the whole dock is all done from two central positions on the top of the dock towers, where the valve wheels and connections are placed. The valve-houses are directly in communication with the engine-rooms, so that the man in charge has complete control. Indicators are fitted to show the positions of valves, whether open or shut, in order that the dock-master may take up different positions for conning the lift. As the dock is intended especially for naval purposes, special provision has been made for supporting the armor belt of battleships. There is a strong channel running along the top of the broad altars to take the heels of the vertical shores. Channels are also provided to take the ends of the raking shores which are used for supporting the bilges. There are six capstans for warping ships into position, together with the usual bollards, fairleads, etc. Electric current is provided for illuminating purposes by means of a separate installation placed in one wall of the dock. Leads are arranged so that all the interior compartments can be lit up. There are also twelve arc lamps for use when docking or working on a ship at night. There are also special arrangements to facilitate the use of hand-lamps. Two traveling jib cranes are fitted, as shown in the drawings, running along the walls. They are each of 5 tons capacity, with an acting radius of 36 feet, and clearance to lift 35 feet above the top deck. These are electrically driven, there being separate generating plants placed in the towers of the dock. Current generated, however, can be used either for illuminating or power, the leads for the two generating plants being arranged so that they are mutually interchangeable. They use steam applied by their own boilers.

The bottom of the pontoon is protected by a series of greenheart keels, as it is possible the dock may ground at low water. The bottom of the harbor at Bermuda is of coral. The top decks are teak-planked, and arrangements are made for catching rain-water, as fresh water is somewhat scarce in Bermuda. The pumping machinery of the dock has been provided and erected by the Wallsend Slipway and Engineering Company, the engines and pumps being made by Messrs. Allen & Co., of Bedford. The electric machinery and the cranes are by Messrs. Clarke, Chapman & Gurney, of Gateshead, the same firm having supplied the steam capstans on the top deck.

It will, perhaps, be of interest if we make further reference here to the big American dock already mentioned, which was completed last year, and which was built in the United States, at the Maryland Steel Company's yard at Sparrow's Point, to the designs of Messrs. Clark & Standfield. Although the new Bermuda dock exceeds the American structure in length by 20 feet and in weight by 650 tons, the latter has greater lifting capacity. It has recently lifted the United States battleship "Illinois," a vessel of 11,565 tons displacement. This, however, was well within its powers, as up to pontoon level it will raise 18,000 tons; and if the "pound" were utilized, the capacity could be increased up to 20,000 tons. Comparing the two docks on equal basis, the weight of hull to lift each 100 tons of vessel is 33 tons with the American-built dock, and 39 tons with the British structure. It may be added that the American naval authorities have a somewhat different method of docking to that followed in this country; how far this affects the structural weight of the dock we are not aware, though it certainly affords a saving in shores. The American plan is to attach to the bottom of the ship exterior longitudinals or stout side keels. Rows of blocks are placed for these as well as the usual blocks for the central keel. As a consequence, the ship sits on a broad base, and needs no shoring, excepting that required for centering. The American plan saves time in docking; but in discussing the merits of the two systems, an English ship designer might say that a ship passes very little of her time in drydock, and it is better that extra weight should be at rest in one drydock than that hundreds of ships should have to transport the burden all over the world. Of course, ships must have material worked in to afford longitudinal stiffness; but whether it would pay to put it outside the bottom is a matter that may be well open to discussion.

When completed, the dock will be towed round to the Medway, where, it is said, it will be tested by docking a battleship; after which it will be taken to Bermuda, to occupy the place of the old floating dock which was taken out in 1869.—Engineering.

CONTEMPORARY ELECTRICAL SCIENCE.*

SPONTANEOUS IONIZATION OF GASES.—It has previously been shown that there is a continuous production of ions in air contained in a closed vessel, even when it is not exposed to any ionizing agent. C. T. R. Wilson has measured the relative rates of production of ions under such conditions in air and certain other gases. These rates of production were obtained by comparing the saturation currents in the various gases. The vessel in which the ionization was measured was a glass bulb thinly silvered internally. The conducting system, from which took place the loss of charge to be measured, consisted of a brass wire with a narrow strip of gold leaf attached, the wire being fixed by means of a small bead of sulphur to a brass rod passing through a plug of sealing wax in the neck of the bulb. This supporting rod was kept at a constant potential by means of a condenser, consisting of zinc plates embedded in sulphur. Electrical connection could be made when required between the leaking system and the supporting rod by means of a strip of watch balance-spring, soldered at its upper end to the supporting rod, and with its lower end bent so as to form a bridge over the sulphur bead. By approaching a magnet to the neck of the bulb the free end of the spring could be brought into contact with the upper end of the brass wire carrying the gold leaf. The position of the gold leaf was read by means of a microscope provided with an eye-piece micrometer scale. It was found that the leak was proportional to the pressure, except at the higher pressures. For the lower pressures the rate of leak may be taken as a measure of the ionization. The following were the relative ionizations: Air 1.00, hydrogen 0.184, carbolic acid 2.64, and chloroform 4.7. Except in hydrogen the ionization is very nearly proportional to the density of the gas. It would follow that a certain weight of gaseous matter always contains the same number of ions, but this number is lessened at higher pressures, and in hydrogen the ionization per weight is two and a half times as great as in the other gases. The author mentions the possibility of the ionization being due to a radiation from the walls of the vessel, which might be absorbed at the higher pressures, but he does not consider this explanation proved.—C. T. R. Wilson, Proc. Roy. Soc., January 31, 1902.

*Compiled by E. E. Fournier d'Albe in The Electrician.

ROTARY FIELDS.—Since the work of Ferraris, it is known that a rotating magnetic field may be obtained by a suitable combination of two alternating fields at right angles to each other, and arranged so that the vector of magnetic force rotates about its origin. This gives rise to a magnetic field rotating in a fixed plane. J. J. Taudin Chabot describes a generalized method of producing it which enables us to vary the plane of the rotating field, and thus produce a rotating fall in three-dimensional space. It is done by combining two or three rotary field-rings at right angles to each other. The author has constructed a model of three such circuits, and suspended an electromagnet within it by means of a Cardani suspension. A similar system, which he calls the receiver, was placed at a distance and communicated with the first, but a needle of soft iron was substituted for the electromagnet. When the latter was excited by an alternating current the needle followed any rotation that might be imparted to the electromagnet.—J. J. Taudin Chabot, Physikal Zeitschr., February 15, 1902.

TIME REQUIRED TO EXTRACT PRECIOUS METALS.

IN every kind of treatment for the extraction of precious metals from an irregularly constituted substance like a natural ore, it is plain that the element of time plays an essential part. Whatever may be the solvent—whether quicksilver, cyanide, or the fluxed media of the smelter—it is obvious that while one metallic particle is snapped up instantaneously, the next (occluded possibly by some protective envelope, or otherwise rendered refractory) may require a greater or less interval before entering into the necessary combination. It will be seen that the economic problem thus really turns upon the most effective average of time allotted to a continuous process. In other words, it consists in determining the exact point at which the least possible amount of value is lost, and the least possible time wasted in trying to save it. To delay a whole process in order to conquer one refractory morsel would clearly be as bad economy as to hurry through a large pile at the cost of losing a considerable number of such morsels. Here again the possible value of an intermittent action seems to be suggested—that is to say, an action interrupted at intervals sufficiently to allow time for the absorption of less accessible particles. It may be argued that in any smelting process any such designed irregularity is wholly impracticable, which is no doubt true enough; this is, however, the case where the occasion for it least frequently arises—the fusion of the mass being necessarily of long continuance, and its movement not being imparted by any rhythmic mechanical impulse. But in every instance where that is the case—as (to cite another example) in the precipitation of gold-cyanide solution on zinc—the periodical arrest, or even change of speed, in the movement would afford the extra chance for contacts which otherwise might be missed. For, even a steady flow of water in a fixed channel acquires an undulatory motion mechanically similar to that of an oscillating table or any other machine action. If we can imagine an approximate halt, or pause, to occur in such action at intervals of a few seconds, it is easily conceivable that each such break might determine the complete absorption of certain portions of valuable matter which otherwise would have escaped. The same might be the case, though perhaps to a less extent, in pan amalgamation or any process in which contact is brought about by the stirring of the liquid by horizontal arms. There may therefore be a practical value in any device having for its object the principle of breaking the uniformity of a mechanical action without an undue loss of time.

It is yet too early, perhaps, to refer in this connection to the more recent processes of dry treatment of the precious-metal ores, and the obstacles which are presented in developing them. The problem, however, remains substantially the same, viz., the bringing about of a direct and rapid contact between the particular constituent to be saved and the reducing agent which is able to get hold of it. In the case of a quicksilver contact (usually the one here involved) it is to be considered whether such contact takes place more readily in a surrounding medium of water or of air. Assuming the surfaces of both substances to be clean, a simple experiment will show that the chances are much in favor of the latter, the obvious reason being that the lighter medium offers proportionately the less resistance to rapid motion, thereby enabling the contacts of the several particles to occur at shorter intervals. Against this must be set the lesser chance of clean surfaces in dry air than in water, unless greater force is employed to insure the contact. A globule of mercury lightly coated with dust is protected from contact unless the covering happens to be penetrated at the moment of impact upon the metallic particle it is intended to absorb. This, however, is probably counterbalanced by the fact that in a dry process a larger proportion of the force (being used in a less resistant medium) is actually expended upon the pulp itself.

Summarizing these remarks, it appears likely that the question of the economic adjustment of time will prove to be the leading factor in the progress of ore-treating methods. The ancient Mexican "patio" process, in which the complete treatment of a single charge occupies from five to six weeks, approaches reasonably near to perfection in its results. The problem of the present day is to accomplish the same approach in five or six days, or less if possible. It has often been remarked by those who have speculated upon the wondrous architectural structures of ancient Egypt that in those times there were two conditions available which are differently regarded now, viz., unlimited time and unlimited manual labor. Whether it required one month or three to quarry, dress, and transport one of the vast blocks composing a pyramid, when time and hands were probably not measured by weekly pay rolls, was of little moment. But in modern days, while aiming (as we hope) at the "greatest good of the greatest number," we have also to aim at the greatest result in the least time. It is simply a question of how much value we can afford to throw away in order to save the rest rapidly. And this is in fact, the directing rule which must control our designs for the betterment of all our milling methods.—Mines and Minerals.

MINE EXPLOSIONS.

IN an article in Mines and Minerals Mr. Austin King, after describing mine explosions in the Bituminous region of Pennsylvania since 1833, says:

The indirect causes of the explosions were as follows:

Neglect of superintendent	1
Neglect of mine foreman	8
Neglect of fire boss	1
Carelessness of miners	3
Carelessness of shot firer	1
No examination of mine	1
Unforeseen cause	5
Unknown cause	1
Unexplained by mine inspector	1
Total	22

It is worthy of notice that no lives were lost that can be traced to the use of safety lamps, also that 19 of the 22 explosions occurred in the Pittsburg seam of coal.

Having outlined the various disasters, and, to the best of our knowledge, their causes, the question naturally arises: What lessons have they taught us? We trust they have taught us to bear in mind, to carefully guard against future accidents by removing, as far as we can, the causes that rendered them possible, together with any others that our riper experience or knowledge might set down as likely to result in their repetition. When about to open new mines, where from the position of the seam and the mining history of the locality gas might be reasonably expected, we should make provisions at once for ample ventilation, because the great diluter of gas is plenty of fresh air.

By ample means of ventilation is meant, that fans capable of ventilating the mines thoroughly should be selected; that large air shafts, and, if the conditions of the seam permit, large airways numerous enough at the start to allow the division of the air as close as possible to the fan; that the divisions of the air volume should be as many as will combine the least resistance to the passage of air through the airways with a brisk air current, regulated according to the needs of each; that overcasts necessary to these divisions should have large area, and be well and substantially built; that doors be properly placed and hung so as to close by gravity; that brattices along main airways should be built of masonry; where these are only of a temporary character—to last but a few years—they should be tightly built of wood and kept well up near the working faces; that check doors of canvas should be used to deflect the air current so as to sweep the rooms, ends of ribs, and edges of gobs; that air on its way to the workmen should be kept free from any pollution from old gob or workings, and should reach the farthest in workings as pure and fresh as possible.

Safety lamps of the most approved type should be used, and men instructed in the proper use of them.

The use of safety lamps should be compulsory in all mines when they are not or cannot be ventilated so as to keep the working places, roadways, and gobs so clear of gas that a "cap" cannot be detected therein; or where, if the ventilation was interrupted for a short period, gas would be present in above-named places in dangerous quantities.

We also believe that safety lamps should be used exclusively in mines where gas is emitted freely, whether blasting is or is not done. We are acquainted with mines at the present day in which blasting is successfully carried on, and where it would be exceedingly dangerous, if not impossible, to work with open lights. In such mines as these shot firers should be employed. They should have charge of all explosives and blasting apparatus.

One of the most important duties to be fulfilled is the examination of the working places, the places adjacent to them and the roadways. These examinations should be faithfully made, marked, properly recorded and reported before the shift commences work; the persons working in places where gas has been discovered in dangerous quantities, and in places adjoining, should be prevented from going into them until the danger has been removed. If the danger cannot be removed during the day, the place or places, and those contiguous to them, should be fenced off by post and board, and danger signals placed at each entrance to them before the next shift commences work.

What amount of gas constitutes a dangerous quantity will be very different in a mine in which the most approved safety lamps are exclusively used, and in one in which only open lights are used. Men using the best safety lamps may be allowed to work with all reasonable safety in places where quantities of gas may be contained in the gob, because it is possible to have good ventilation in the working places and around the edges of gob falls, and at the same time be practically impossible to clear the gas from the gob. In fact, in some sections, no gob in the earlier stages of formation is clear of gas. Later on carbonic gas sometimes proves a valuable neutralizer.

During disturbances, such as movements of the strata in squeezes, or when cutting faults or clay veins where no gas has been observed in the past, great vigilance

should be exercised in the search for it, more especially if gas has been known to exist in the mines or wells in the vicinity.

Accurate surveys should be made and kept up so that the accidental perforation of boundary pillars will not occur.

Discipline should be as strict as the circumstances require, and the pockets of workmen in the mine should be examined from time to time to ascertain whether or not pipes or matches are carried into it. The workmen employed should be as intelligent as the condition of the labor supply will allow. In fine, we should comply with all the provisions of our excellent mining law.

A BIT OF THE "ANCIENT" HISTORY OF THE ISTHMIAN CANAL PROBLEM.

By JOHN MEIKLE.

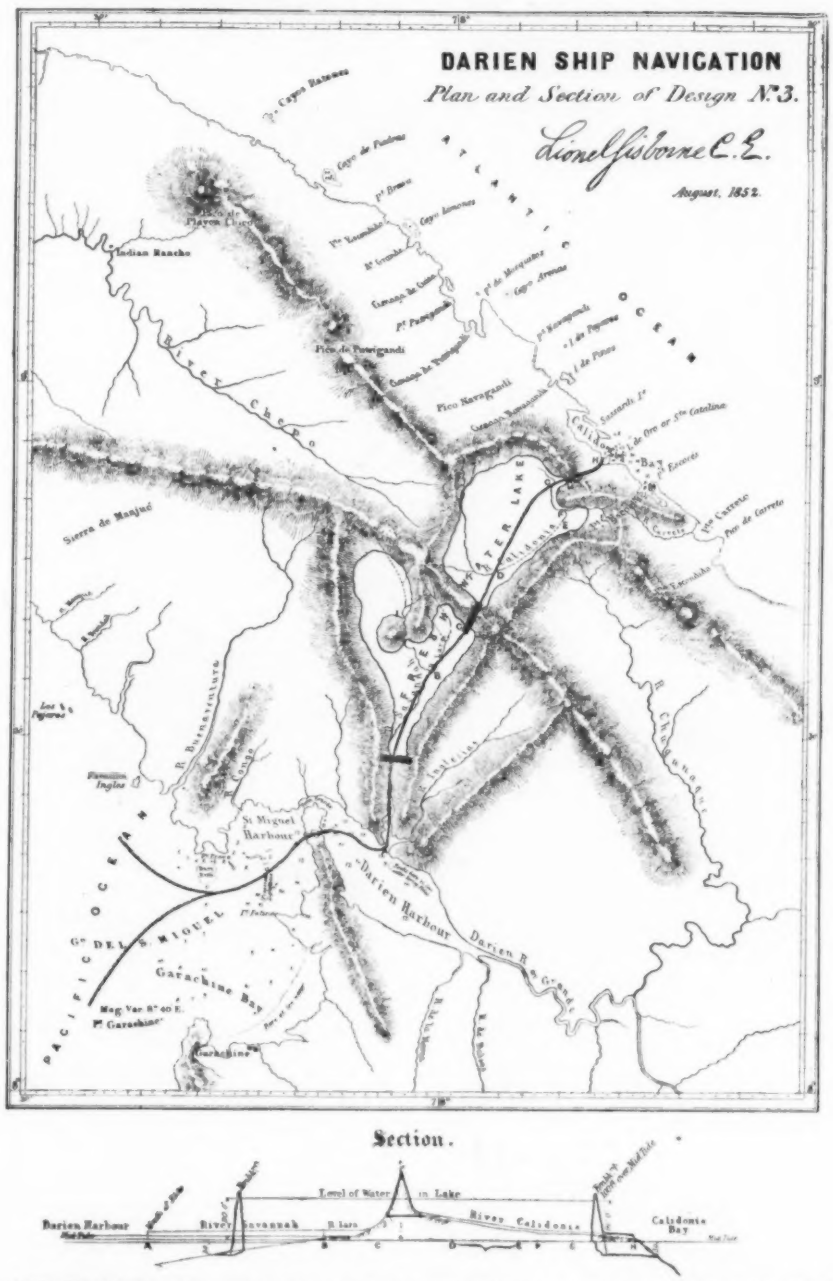
IN December, 1851, one Dr. Cullen, claiming some repute as a Central American explorer, created a certain degree of sensation in London among geographers, engineers and capitalists by appearing there and announcing the discovery of an easily practicable interoceanic canal across the Isthmus of Darien. He had landed, he said, on the shores of the Gulf of San Miguel, on the Pacific, and made his way, practically unimpeded, over to Port Escoces on the Atlantic, finding a low summit level, and otherwise a traverse of quite irresistible fascinations, from the point of view of the ship-canal builder. Engineers had grave doubts of the reliability of so glowing a relation, but the story attracted attention, and finally led to the setting on foot of a preliminary survey, the direction of which was confided to a civil engineer of good professional reputation. Sir Charles Fox, Mr. John Henderson, and Mr. Thomas Brassey, all railway builders and engineers of renown then, formed themselves into a small syndicate to finance the proposed investigation. Sir Charles Fox (born 1810, died 1874) was chief of the firm of Fox, Henderson & Co., of London, the constructors of the London Exhibition building of 1851, after the design of Paxton. Thomas Brassey (born 1805, died 1870) was he who built the Grand Trunk Railway of Canada, and executed many other big undertakings in all parts of the world. These gentlemen selected as their surveyor Mr. Lionel Gisborne, of London, and appointed Mr. H. C. Forde as his assistant, both being civil engineers by profession.

On the 2d of April, 1852, Gisborne and Forde left Southampton by the "Great Western," one of the fleet of the Royal Mail Steam Company, bound for the West Indies, and thence to Cartagena, where they arrived without incident on May 1. Dr. Cullen, the reputed discoverer of the "one and only ship-canal route," that was to dish finally, so it was said, the rival claims of Nicaragua, Panama, the Atrato, and the Chiriqui Lake, had, before this, returned to Central America, on the understanding, however, that he was to be in readiness for the arrival of Mr. Gisborne at Cartagena, there to form an important member of the small party of survey and exploration. As planned out, the scheme included the chartering of a small sailing vessel at Cartagena, with which to make westward along the coast to Port Escoces or Caledonia Bay. In the report subsequently issued, Caledonia Bay is set down as about five miles to the northwest of Port Escoces, and about 115 miles to the southeast of Navy Bay, at the mouth of the Chagres River, where the Panama Railway was then in course of construction. But Dr. Cullen did not keep appointment; and so, after spending some four or five weeks at Cartagena fruitlessly, Mr. Gisborne chartered there the small schooner "Veloz," stored her, and left on June 12 for the natural harbor called Port Escoces, which was safely made three days thereafter. At that time, this section of the crossing (barring the doubtful Dr. Cullen traverse) was considered as having been altogether untouched by white men since the days of the buccaneers. The Indians of the Atlantic coast there, though few in number, were jealous of visitants, and as far as lay in their power closed the coast line to intruders. On the Pacific side, along the course of the Savannah to its mouth in Darien Harbor, report said there were no inhabitants other than the wild animals of the region. It was between these two points that Dr. Cullen on his own showing only, had made successful traverse. Mr. Gisborne found the Port Escoces inlet deep, of good anchorage, and accessible at all times, though partly exposed when winds blew from the northeast. High Cordilleras appeared to range uninterruptedly along the isthmus; the only signs of habitation were an Indian village to the southward and a few huts at Caledonia Bay. Port Escoces itself seemed to be entirely solitary.

On June 17 Gisborne and Forde landed at Port Escoces unobserved, and began the ascent of the coast range, passing the first crest 220 feet above sea level, and doubling the second at 276 feet height. From here, away to the southwest in the direction of the Gulf of San Miguel, no high ground could be discerned, and the explorers began to flatter themselves that they had already got into the Pacific watersheds, especially as the first stream they encountered in their descent had its course in that direction. This they took at first to be one of the head feeders of the Chuqunaque, which in all the maps then published was made to rise well to the north of Port Escoces and Caledonia Bay, and to run a long course parallel to the Atlantic, before winding round to the south for junction with the Rio Grande or Darien River. The night was passed on the banks of a somewhat larger stream into which that first discovered flowed, and it was while following its leisurely curves next day that they came upon Indians, who, without offering violence, took them into custody, so to speak, and embarked them on one of the canoes, still following the current of the same river of moderate volume, which, however, soon so diverged in its course as to point northward first, and then about due east in the direction of the coast range scaled the previous day. In point of fact the river had passage through the coast ridge by a gorge neither discerned nor suspected in the survey from the topmast of the schooner, and finally finished its course in the Atlantic at Caledonia Bay. This was a reversal of the theory of the explorers, but encouraging on the whole in thus, as it were, presenting a ready-made passage through the Atlantic ridge if a sea-level canal were to be undertaken at this point. At the same time, it seemed to indicate that the Chuqunaque did not rise so far north; that it did not overlap Port Escoces and Caledonia Bay, and that the maps were wrong. The Indians escorted the intruding white men back to their vessel at Port Escoces, there warning them off the ground, under threats of drastic measures if loitering were continued or trespass repeated. The party sailed at once for Navy Bay, and thence took rail as far as by that time constructed, thereafter boating part of the way on the Chagres, and finally completing the journey to Panama on mule-back.

At Panama no time was lost in hiring a small coasting craft for the run to Gulf San Miguel. Departure was made on June 27, and the mouth of the great Pacific inlet was reached next day. Entering the Inner or Darien Harbor, by the Bocca Chica, they crossed over to the mouth of the Savannah River, which they found two miles wide and with nine fathoms depth at low water. This river they ascended some eighteen miles, as far as it was prudent to take the sloop, which was there anchored, the rest of the riverine survey being done in a light canoe. After thus canoeing about eight to ten miles farther, Gisborne and Forde, leaving their sailor attendant to await their return, struck northeastward over a dip in the mountain ridge, finally making, as they reckoned, to within six miles of their most inland point on the occasion of the checked expedition from Port Escoces, having by this time fallen in with a river course which they had no doubt was their former greatly winding acquaintance, with its embouchure in Caledonia Bay. The northeasterly view here was over tempting meadow-like country, with the Atlantic ridge in the distance. So far, no signs of habitation were met with, the region indeed being uninhabited; but they were now on the fringe of the territory of their old friends, or enemies, of Caledonia Bay, and did not deem it necessary, at so great a risk, to actually complete the traverse. Retracing, therefore, they ascended in their canoes the Lara River, a straighter tributary of the Savannah, and decided that the canal on its middle course would be better served by following its line. Returning to Panama, the explorers there at last came across the unaccountable Dr. Cullen, and some sharp words passed, Mr. Gisborne refusing to show him the maps and plans he had sketched, and refusing also to give him more than the merest outline of information. All through, this Dr. Cullen smacks something of the empiric or adventurer; he seems to have got stranded at Panama, with his finances at a low ebb, and here indeed the story parts with him finally. Retracing their course again rather laboriously across the isthmus, by mule, boat, and rail, the explorers reached Aspinwall; the next day the Trent steamer called and picked them and a few other passengers up, and ultimately on the 17th of August they were landed at Southampton after an absence of four and a half months.

Mr. Lionel Gisborne issued his report to the high syndicate (as above specified) on September 10, 1852, accompanied by various plans and maps. In this official report he describes the harbors of San Miguel on the Pacific and Caledonia Bay on the Atlantic as both "excellent as the termini of a ship navigation on the largest scale, with Port Escoces as a harbor of refuge should circumstances occur to render its use necessary." The Savannah, he said, had six fathoms or upward of depth at low water for a distance of seven miles from its mouth, the effect of the tide reaching up the Lara tributary eleven miles above this, or eighteen miles in all from Darien Harbor, leaving a distance of thirty miles to Caledonia Bay, which at this crossing was the actual breadth of the Isthmus between the tidal effect of the two oceans. A summit level of only 150 feet was assured, consisting of a narrow range of hills with a gradually rising plain on either side; but there was good chance, the report said, of a still lower summit level being discovered, as the result of a more intimate survey between the two points. He proposed to make a sea-level cut 30 feet deep at low tide, 140 feet broad at bottom, and 160 feet at low-water surface line. Excavation would be confined mainly to stratified shale of thinnish beds, easy to get, though sound, and fitted well for an ultimate side lining to the navigation way, by dispensing with the necessity of any artificial protection. His estimate for such a tidal canal was twelve millions of pounds—equal to about fifty-eight million dollars. The report in the strongest terms recommended the scheme thus outlined, a scheme, he said, "which will, without locks, at all times permit the passage of the largest vessel, and it is with pointedly expressed regret that he finds it his duty (as instructed) to submit any alternative proposition. The alternative took the shape of a navigation of two levels, with a total lift of 90 feet. The Savannah and the Caledonia Rivers would each be embanked, the former at a point up to which it is naturally navigable, and the other at the western side of the ridge through which it penetrates on its way to outfall in the Atlan-



PLAN AND PROFILE OF SURVEY MADE IN 1852 FOR A CANAL ACROSS THE ISTHMUS OF DARIEN.

tic. These two huge dams would procure the creation of two great lake-like catchments, occupying about two-thirds of the entire crossing, and separated by a comparatively narrow dividing range midway, through which of course the waterway would have to be cut. Caledonia River, in addition, would need to be deeply excavated from the Atlantic up to the site of its embankment. The lift of 90 feet was to be overcome by a suite of three locks, each 400 feet long, and of individual lifting capacity up to 30 feet. The bulk of the canal course would be through these artificial reservoirs, of a capacity sufficient to permit of a shrinkage of 10 feet for lockage during the dry season, without detriment to the upper-level navigation. For a six-lock waterway of two levels thus, the engineer estimated an outlay of four and a half million pounds, equal to twenty-two million dollars.

A plan and profile of the proposed alternative of a canal of two levels are here reproduced from the originals as published, and they are interesting as showing graphically the notions of this English engineer of half a century ago regarding the work proposed to be realized; but it is significant that in the report itself, from which the foregoing data are taken, he "purposely abstains" from entering into any details, or into any speculations as to constructive arrangements, or to duration of time estimated as needful for execution.

Shortly after this the New Grenadian government granted, it would appear, to Sir Charles Fox and his coadjutors concession of lands and privileges, but, as we know now, nothing came further of the project. Probably this very hasty survey (not more than eight full days on the actual ground itself) was finally regarded as too much of mere dilettantism in engineering, and perhaps deservedly so. Gisborne published his "Journal of the Expedition," which makes entertaining reading enough, though irrelevant a good deal of it, and within the same boards there were presented the formal report itself and four sheets of maps, plans, and sections.

Glasgow, Scotland.

THE PRINCE REGENT THEATER, MUNICH.

ONE of the most notable playhouses in Europe is the Prince Regent Theater of Munich. The accompanying illustration, reproduced from Building News, from a drawing furnished by the architects, Heilmann and Littmann, shows how wonderfully complete are the appointments. The general arrangements of the audience and the stage are clearly shown. The foyer hall is seen at the front of the drawing, at right angles to the theater, and leads into a small inclosed garden forming part of the site. The absence of galleries in the auditorium is a very striking feature.

IRON AND STEEL EXPORTS.

PROSPERITY at home and depression abroad are cited as the principal causes of the continued fall in the exportation of manufactures of iron and steel. Two items in the exports of the United States now show a marked reduction compared with those of last year —corn, and manufactures of iron and steel. Exportations of corn in the eight months ending with February, 1902, amounted, according to the preliminary figures of the Bureau of Statistics, just issued, to only 29,912,875 bushels, against 132,624,859 bushels in the corresponding months of the preceding fiscal year, the value being in the eight months ending with February, 1902, $13,683,200, against $60,621,569 last year, a reduction in this single item of $46,938,369. This reduction, of course, was caused by the shortage in the corn crop due to the drouth of last summer.

The other important item in which a reduction is apparent is manufactures of iron and steel. The exports under this head are for the seven months ending with January, 1902, $16,000,000 below those of the corresponding months of last year, being $57,310,128 for the seven months ending with January, 1902, against $73,616,467 in the seven months ending with January, 1901. This decrease in the value of iron and steel exports is said by those interested in the iron and steel industry of the United States to be as easily explained as the decrease in the exportations of corn above referred to.

The cause of the phenomenal growth in the exports of iron and steel manufactures within the past few years was the depression existing in the home market from 1893 to 1897, by which the demands upon American manufacturers were small, and which condition was immediately followed by unusual demands for iron and steel manufactures abroad, thus enabling the American manufacturer to enter the markets of those countries. At the present time conditions are, to a considerable extent, reversed, the demand abroad being considerably reduced and that of the home market, according to the best authorities in iron and steel, being absolutely in excess of the producing capacity of the iron manufacturers and of the railroads to handle the products so demanded. The result is that the manufacturers are naturally turning their attention to the supply of the home market; and in certain classes of their products, notably pig iron, steel rails, steel plates and structural steel, there is a considerable decline in exports, which may be expected to continue so long as the home demand equals or exceeds, as at present, the producing capacity of the manufacturers and the carrying capacity of the railroads. In other lines of iron and steel the exportations continue at about the former figure, especially in agricultural machinery, tools, builders' hardware, etc.

The following table shows the exports of principal articles of iron and steel manufactures in the seven months ending with January, 1902, compared with the corresponding months of the preceding fiscal year:

Articles.	Seven months ending with January 1901.	1902.
Pig iron (tons)	232,506	45,158
Bar iron (pounds)	31,326,242	13,682,477
Bars or rods of steel (pounds)	166,834,554	38,571,104
Hoop and scroll iron (pounds)	6,584,268	2,296,574
Billets, ingots, etc. (tons)	108,619	2,249
Steel rails (tons)	199,122	132,539
Sheets and plates (pounds)	85,514,687	18,489,620
Wire (pounds)	88,380,282	123,137,826
Builders' hardware	$5,384,402	$5,152,714
Electrical machinery	$3,211,179	$2,963,696
Metal-working machinery	$2,789,524	$1,786,998
Pumps and pumping machinery	$1,343,116	$1,243,006
Sewing machines	$2,521,255	$2,201,165
Locomotive engines, number	223	201
Typewriters	$1,568,209	$1,751,789
Nails and spikes (pounds)	42,204,550	22,739,434
Total value of exports	$73,616,467	$57,310,128

USE OF EYEGLASSES IN THE ARMY.

"FIGHTIN' all day, sir, and never saw a Boer. Yas, sir, we simply blazed away at the kopjes on the chance of hittin' a Boer or two." In a trenchant article on recent ophthalmic work in the British army, Dr. John Grimshaw tells us that this was a very frequent statement from the invalided South African soldiers on being asked whether their eyes had given them trouble when shooting on the veldt. American military surgeons also had occasion to direct careful inquiries into the relation of vision to efficacy in the various departments of the army and navy in our recent war with Spain.

Because of the interest shown in these two countries it can but prove profitable to compare the standards of vision established in Continental Europe with those in force in England and America. For this purpose one cannot do better than turn to an article on "Standard of Vision" by Capt. Miles Standish. In the first place the enlisted European conscript is permitted to wear glasses; this, except under quite unusual conditions, is prohibited in England and America.

In the French army regulations of 1894, which are at present in force, the requirement of vision after correction of myopia is ½ with both eyes together, and not less than 1-10 in the poorer eye; in cavalry and artillery, normal vision in one eye and not less than ½ vision in the other.

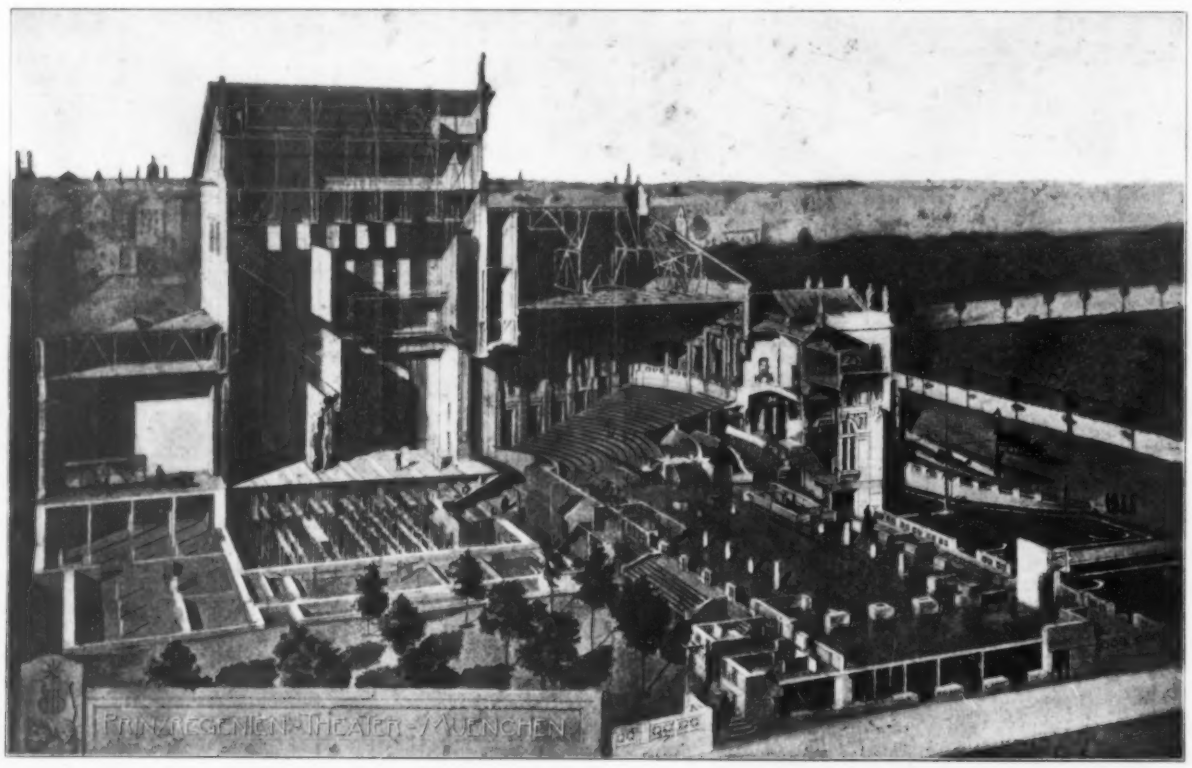
In Italy the royal decree of September 26, 1881, rules that reduction of vision to 1-3 the normal in the right eye, or to 1-12 in the left eye, although vision in the right eye is up to normal, if caused by organic changes or incurable disorders of the globe of the eye, a very important qualification, incapacitates for military service. The latest Belgian regulations determine that reduction of vision in the right eye to 1-3 of normal causes exemption from service, although reduction of vision below this limit in the left eye does not exempt from duty. The Swiss army regulations for the minimum of vision for the artillery is normal; for the infantry 3-5, and for all other troops ½. Whenever the vision in one eye is normal, vision in the other may be as low as ¼; but these conditions do not allow men to be employed as riflemen unless the eye with normal vision is the right eye. The rules in the Danish army exclude from military service all men having vision below 1-5.

These standards are too low to be brought into relation with those employed in the examination of candidates for the United States army, which, as would be expected, are by long odds the highest in the world. They are 20-20 in *each* eye, without glasses. That this standard is unnecessarily high may be judged from the fact that when, upon the outbreak of the late war, large numbers of members of the National Guard were rejected for "physical disability" by the United States examining officers, the natural inference among the laity was that the State troops were mostly cripples and invalids. A 20-20 vision would theoretically enable the soldier to see a man six feet high at a distance of 1,375 yards, but as a matter of fact, owing to atmospheric and other conditions, a man could not be distinguished at any such distance.

In England it would seem that, while the visual tests are probably grossly tampered with by bribing and other nefarious methods, and while, as is frequently the case, the Englishman has a more or less archaic method of estimating the eyesight, it might be interesting to question whether in the last forty years the national eye, if one may use the term, has become dimmed and whether the lamentable picture of Thomas Atkins shooting at kopjes in lieu of Boers is a result of *this* or of faulty or mismanaged examination. Grimshaw asks why, if the War Office grant artificial teeth to men who are likely to become efficient soldiers, should spectacles be withheld?

There is little doubt that England will soon realize that she must take her place in company with the Continental people and furnish glasses as they do. Obviously this is an admission that she has in the last half century lost ground physically. It would seem in retrospect that this question of eyesight in the army affords a tolerable insight; a sort of indicator to the well-being of a nation. Continental Europe has "glassed" a large proportion of her soldiers; this proportion increases from day to day, and it is noteworthy that the ratio is highest in the poorest lands. Lord Kitchener's strictures on the physical unfitness of the proud Imperial Yeomanry show that even they, in company with the rest of the British army, must submit to the wearing of glasses or fail in the race. The yeoman is extinct.

Our own authorities ask for a lowering of the standards. If these premises be true, how long, one can but ask, ere our proud standard must fall, crushed, with many other good things by the onward march of civilization"? How soon will the "glazing" of



THE PRINCE REGENT THEATER, MUNICH. (LONGITUDINAL SECTION.)

our iron regulars proclaim to the world our national decay? When will our 20-20 standard be borne by that same westward tide to the vigorous New World which, portent says, will one day take life in the dead East?—Medical News.

THE SIEGFRIED PERFORMANCE IN PARIS.

ONE may well say, that the performance of Richard Wagner's "Siegfried" at the Grand Opera on January 3 was the greatest theatrical event of the present winter season at Paris. Wagner's music has long ago made its final entry into Paris, for truly great and masterly creations everywhere make a victorious and all-conquering way for themselves.

And thus Frenchmen soon saw their first error, and it must be admitted that they now earnestly and sincerely try to remedy the former misunderstanding. In fact, the Grand Opera in Paris gives a costly and magnificent frame to Wagner's music dramas and knows how to endow them with artistic taste, such as only the fancy of a Wagner could have dreamed of. Added to this, the Parisian public has a high appreciation of art. Richard Wagner himself once said that he would be best understood in France. He doubtless was convinced of the high and unerring faculty of the French for judging all matters of art. They would no doubt have judged rightly from the first, if it had not been for the miserable spirit of Chauvinism. But since then they have slowly and step by step come to a better understanding.

The "Flying Dutchman" ("Le Vaisseau fantôme"), "Lohengrin," "Tannhäuser," the "Walküre" and the "Meistersinger" were one by one performed in Paris. The military concerts in the pavilions of the promenades and public parks made the French people acquainted with Wagner's music, and gradually thus the French were won in Wagner's favor.

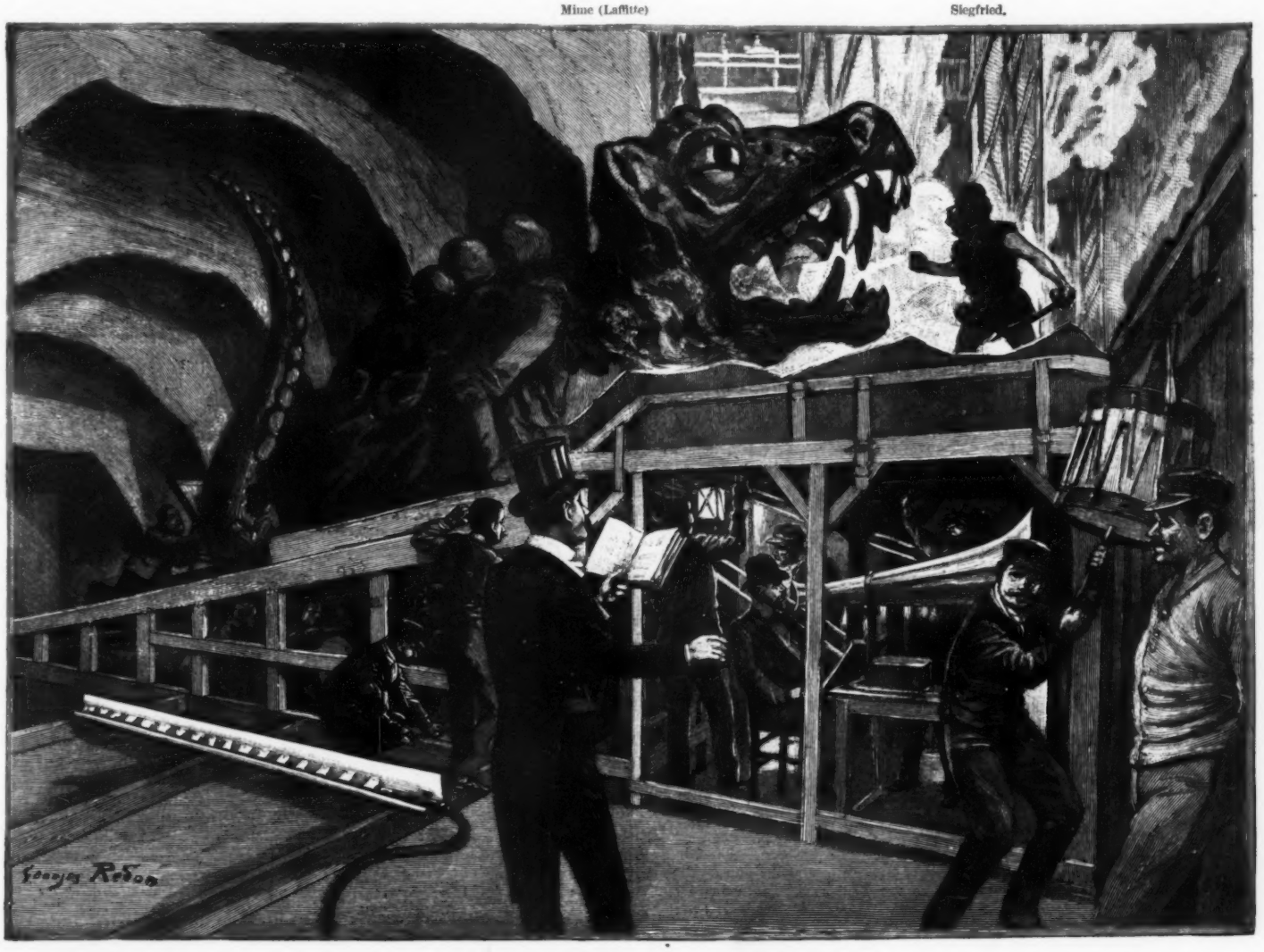
The performance of "Siegfried" at the Grand Opera made an overwhelming impression on the Parisians. On "Siegfried" nights the house was always sold out, and every seat taken. Indeed, the first performance was in every respect a gala night.

All elegant, aristocratic, artistic and literary Paris was fully represented, and received the performance as a veritable triumph. Concerning the rendering of the opera, the first "Siegfried" performance had not yet attained the height of perfection: This was only done in the following ones. The task was too great for the first performance to fully succeed in all its parts. The orchestra under Taffanel's usually so excellent direction, repeatedly drowned the voices on the stage. Jean de Reszké as Siegfried had not quite recovered from an indisposition; his voice seemed now and then tired. Laffitte as Mime also was not yet quite at home in his difficult part, and exaggerated sometimes more than was approved by strict Wagnerians. The dragon Fafner was still somewhat unruly toward the machinists, and the electricians could have handled their light-rays more evenly. At the second and still more so at the third performance these imperfections and roughnesses were smoothed out in the most advantageous manner, and only now did the "Siegfried" performance afford complete enjoyment. Possibly the German Wagnerian would find something here and there to criticise in the French representation; possibly also, the French text makes it more difficult to render Wagner's peculiar poetic-fantastic drama with fidelity. The translation is by Alfred Ernst, who has translated all Wagner's operas into French, with the exception of "Tristan."

Jean de Reszké sings with great assurance, and shows also in his acting that he is a true artist, who has absorbed Wagner's spirit. M. Delmas' Wotan ("Le Voyageur" in the French text) is a remarkable rendition, and his duet with Erda, who was represented by Mlle. Héglon, had an overpowering effect. Laffitte acted and sang Mime very naturally and in the approved Wagner style, and with Siegfried was called out four times after the first act. In the third scene of the second act he had a clever partner in M. Noté as Alberick, and Mlle. Grandjean, who made a very sympathetic Brunhilde, is counted one of the first singers, because of this performance, although differing from the German conception of this part. M. Paty increased the tones of his sonorous bass voice by means of a speaking-trumpet in the interior of the dragon. Fafner is one of the clever illusions of the "Siegfried" performance; with a length of 12 meters, he indeed gave the impression of a monster. He breathes fire and steam in an incredibly realistic manner. Four strong men move him into the foreground of the cave by means of ropes and pulleys fastened in the interior, and it may be mentioned as a curiosity that his movable tail is carried behind him by a fifth man. Our illustration gives an idea of how it looks in the interior of this technically constructed dragon. The forest bird, charmingly sung by Mlle. Bessie Abott in a clear, bell-like voice, flies over the scene three or four times in the most natural manner, moved by an unseen mechanical power, and plentiful sparks and blue fire come out of the sword Nothung, which do honor to the era of electricity.

M. Amable's most artistically executed decorations are among the most beautiful which the Grand Opera possesses. Mime's forge in the first act, surrounded by huge giant trees, between whose trunks the rosy-blue twilight of day shimmers in the background, is a masterpiece. No less pleasing is the cave out of which Fafner emerges later. A jumbled mass of rocks forms the ascent, and a magnificent forest frames it in. The third act shows first the interior of the cave with the grotto out of which Erda rises. Then follows in the third scene on the open stage the transformation of the rock of Brunhilde, which is accomplished very ingeniously with fiery mists rising out of the floor of the stage, finally bringing to the gaze of the beholder the fairylike panorama of a beautiful Alpine landscape, whose loveliness is enhanced when Siegfried, illuminated by the brightly shining sunlight, steps down from the rocky path, high above. The audience was enthusiastic over this truly entrancing picture, and there is no doubt that "Siegfried" will again bring a full house to the Grand Opera in the future. In any case it must be admitted that Director Gailhard has spared no pains to present to the French capital an artistic performance of the first rank.—From the German of Erich Körner in the Illustrirte Zeitung, to which paper we are also indebted for the illustration.

Mime (Laffitte) Siegfried.



The Director. The singer of Fafner.

THE MACHINERY OF THE DRAGON FAFNER. FROM A SKETCH BY GEORGES REDON.—FROM THE SIEGFRIED PERFORMANCE AT THE GRAND OPERA IN PARIS.

DANISH WEST INDIES.

"THE Danish West Indies" is the title of a monograph by the Treasury Bureau of Statistics which will appear as a part of the forthcoming issue of the Monthly Summary of Commerce and Finance. It describes the islands included in the recently ratified treaty of the United States and Denmark, by which the islands of St. Thomas, St. John, and St. Croix are to be transferred to the United States. These islands, it shows, lie off the eastern coast of Porto Rico and are, in fact, a mere extension of the marine elevation of which Cuba, Jamaica, Haiti and Porto Rico are the principal representatives; while they also form a connecting link between the Greater and the Lesser Antilles. St. Thomas, the best known of the group, lies 38 miles due east of the northeastern extremity of Porto Rico; St. John lies 12 miles east of St. Thomas; while St. Croix lies about 50 miles south of St. John and St. Thomas, and 60 miles southeast of the southeastern point of Porto Rico. Two small islands already belonging to the United States, Vieques and Culebra, which were obtained through the cession of Porto Rico, lie directly between Porto Rico and this newly added group.

The islands are small, with a comparatively small producing capacity, their chief importance being by reason of the harbors which they offer and their value as a strategic as well as general commercial standpoint. St. Croix, the largest of them, is about 20 miles long and from 1 to 5 miles wide, with an area of about 80 square miles and a population of about 20,000. It is also the most productive of the islands, a considerable area being devoted to the production of sugar cane and tropical fruits, and agriculture being the occupation of a large proportion of the population. There are two towns on the island, Fredriksted, with a population of 3,700, and Christiansted, with a population of 5,500. The latter is located upon the chief harbor of the island, which, however, is choked with mud and of less importance than the harbors of either of the other islands. St. John, the smallest of the islands, has an area of but about 21 square miles, and a population of only about 1,000, and a comparatively small cultivable area, its chief value being in its possibilities for harbor purposes, the natural harbor of Coral Bay being described as one of the best protected natural harbors in the West

Indies, but at present little used. St. Thomas, which lies nearest to Porto Rico, is by far the most important in its present availability for harbor purposes, the harbor of Charlotte Amalia having been for more than a century recognized as one of the best, if not the best, natural harbor in the entire West Indian group, and having been during all that time a central point as a harbor of refuge and point of exchange for merchandise and a coaling station for vessels from all parts of the world. With passages through which it is easily reached, a good depth of water, and excellent protection from the hurricanes to which that region is subject, it has long been regarded as an extremely valuable harbor, and when Denmark in the early part of the nineteenth century made it a free port it became the distributing point for the commerce of the entire West Indian group. As a consequence nearly the entire population of the island is clustered around the port of Charlotte Amalia, fully 10,000 of the 12,500 population living in this city, and less than 2,000 being engaged in agriculture.

The introduction of steam and electricity within the past few years have reduced greatly the importance of St. Thomas as a point for the distribution of commerce, since now all of the islands in the group are visited by regularly plying steamships, and the trade supplied by this process, instead of being compelled to rely upon the supplies formerly drawn from St. Thomas as a distributing point. The importance of the harbor, however, as a supply, repair, coaling and naval station has not been reduced, but rather increased; and with proper development it will, it is believed, prove of great value, while the productive possibilities of the islands, especially St. Croix, in the class of articles so largely imported by the United States, tropical productions, will not be inconsiderable.

The population is chiefly colored, descendants of former slaves who were liberated in 1848. English is the chief language spoken, especially in the island of St. Thomas, which has been for many years a resort for vessels from English-speaking countries.

The imports into St. Thomas alone in 1900 amounted to $733,000, and those of St. Croix about $420,000. They consist chiefly of foodstuffs and manufactures. The exports of St. Thomas in 1900 amounted to about $25,000, and those of St. Croix $275,000. The exports of St. Thomas were of a miscellaneous character, largely manufactures destined for neighboring islands; while those from St. Croix were chiefly sugar and other tropical products for the United States markets. Of the $733,000 worth of imports into St. Thomas in 1900, $363,266 were from the United States, $148,002 from Great Britain, $98,044 from other West Indies, $53,058 from Germany, $25,372 from Belgium, $20,742 from British North America, and $14,402 from Denmark. Of the imports, the most important were flour, $53,770; cotton goods, $60,343; hardware, $11,114; rum, $13,872; cigars, $19,007; butter and margarine, $16,497; cheese, $7,204; lard, $7,254; and other provisions, $21,128.

ON THE CHEAPEST FORM OF LIGHT.—FROM STUDIES AT THE ALLEGHENY OBSERVATORY.*

By S. P. LANGLEY and F. W. VERY.

THE object of this memoir is to show by the study of the radiation of the fire-fly that it is possible to produce light without heat other than that in the light itself; that this is actually effected now by nature's processes, and that these are cheaper than our industrial ones in a degree hitherto unrealized. By "cheapest" is here meant the most economical in energy, which for our purpose is nearly synonymous with heat; but as a given amount of heat is producible by a known expenditure of fuel at a known cost, the word "cheapest" may also here be taken with little error in its ordinary economic application.

We recall that in all industrial methods of producing light there is involved an enormous waste, greatest in sources of low temperature, like the candle, lamp, or even gas illumination, where, as I have already shown, it ordinarily exceeds 99 parts in the 100; and least in sources of high temperature, like the incandescent light and electric arc, where yet it is still immense and amounts even under the most favorable conditions to very much the larger part.

It has elsewhere† been stated that for a given expense at least one hundred times the light should in theory be obtainable which we actually get by the present most widely used methods of illumination. This, it will be observed, is given as a minimum value, and it is the object of the present research to demonstrate that not only this possible increase, but one still greater, is actually obtained now in certain natural processes, which we know of nothing to prevent our successfully imitating.

It is now universally admitted that wherever there is light there has been expenditure of heat in the production of radiation existing in and as the luminosity itself, since both are but forms of the same energy; but this visible radiant heat which is inevitably necessary is not to be considered as waste. The waste comes from the present necessity of expending a great deal of heat in invisible forms before reaching even the slightest visible result, while each increase of the light represents not only the small amount of heat directly concerned in the making of the light itself, but a new indirect expenditure in the production of invisible calorific rays. Our eyes recognize heat mainly as it is conveyed in certain rapid ethereal vibrations associated with high temperatures, while we have no usual way of reaching these high temperatures without passing through the intermediate low ones, so that if the vocal production of a short atmospheric vibration were subject to analogous conditions, a high note could never be produced until we had passed through the whole gamut, from discontinuous sounds below the lowest bass up successively through every lower note of the scale till the desired alto was attained.

There are certain phenomena, long investigated, yet little understood, and grouped under the general name of "phosphorescent" which form an apparent exception to this rule, especially where nature employs them in the living organism, for it seems very difficult to believe that the light of a fire-fly, for instance, is accompanied by a temperature of 2,000 deg., or more, Fahr., which is what we should have to produce to gain it by our usual processes. That it is, however, not necessarily impossible, we may infer from the fact that we can by a known physical process produce a still more brilliant light without sensible heat, where we are yet sure that the temperature exceeds this. No sensible heat accompanies the fire-fly's light, any more than need accompany that of the Geissler tube, but this might be the case in either instance, even though heat were there, owing to its minute quantity, which seems to defy direct investigation. It is usually *assumed*, with apparent reason, that the insect's light is produced without the invisible heat that accompanies our ordinary processes, and this view is strengthened by study of the fire-fly's spectrum, which has been frequently observed to diminish more rapidly toward the red than that of ordinary flames.

Nevertheless, this, though a highly probable and reasonable assumption, remains assumption rather than proof, until we can measure with a sufficiently delicate apparatus the heat which accompanies the light and learn not only its quantity, but, what is more important, its quality. Apart from the scientific interest of such a demonstration is its economic value, which may be inferred from what has already been said. I have therefore thought it desirable to make the light of the fire-fly the subject of a new research, in which it is endeavored to make the bolometer supplement the very incomplete evidence obtainable from the visible spectrum.

As we may learn from elementary treatises, phenomena of phosphorescence are common to insects, fishes, mollusks, vegetables, and organic and mineral matter. Among luminous insects the fire-fly of our fields is a familiar example, though other of the species attain greater size, and perhaps greater intrinsic brilliancy, especially the *Pyrophorus noctilucus* Linn., found in Cuba and elsewhere. Its length is about 37 millimeters, width 11 millimeters, and it has, like Pyrophori, three light reservoirs—two in the thorax and one in the abdomen. To procure this Cuban fire-fly I invoked the aid of the Smithsonian Institution, and through the kindness of Prof. Felipe Poey, of Havana, and Señor Albert Bonzon, of Santiago de Cuba in the island of Cuba, living specimens of the *Pyrophorus noctilucus* were received here during the summer of 1889. I have also to acknowledge my obligations to Prof. C. V. Riley and to Prof. L. A. Howard, to whose knowledge and kind care I am doubly indebted.

After a preliminary spectral examination in Washington, I found it more convenient to continue the research at the Allegheny Observatory by means of the very special apparatus supplied by the liberality of the late William Thaw, of Pittsburg, for researches in the lunar heat-spectrum. Photometric measurements throughout the spectrum of the insect's light were also made.

I have indicated the steps of the investigation, but the experiments have been so largely and so intelligently made by Mr. F. W. Very that it is just to consider him as an associate rather than an assistant in the researches. I shall accordingly in what follows not discriminate between what each has contributed.

PHOTOMETRIC OBSERVATIONS.

The first impression on viewing the light of the *Pyrophorus noctilucus* through a spectroscope is that it consists essentially of a broad band in the green and yellow, while with precaution we see this extending into and beyond the borders of the blue and orange, but not very greatly farther, and these have been taken by previous observers as its absolute limits. No one appears to have experimentally and distinctly answered the question, "Would the light not extend farther were it bright enough to be seen?" nor has it been proven as clearly as might be desired that the result depends on the quality rather than the quantity of the light, or given conclusive evidence, that if the light of the insect were as bright as that of the sun it would not extend equally far on either side of the spectrum.

It is impossible to increase the intrinsic brilliancy by any optical device, but if it be impossible to make the light of the insect as bright as that of the sun, it is on the other hand quite possible to make the light of the sun no brighter than that of the insect, and this would appear to be the first step in obtaining a definite proof that the apparently narrow limits of the insect's spectrum are due to the intrinsic quality of the light and not to its feeble intensity. The only conclusive method of determining this would appear to be to balance the light from the insect with that of a definite portion of sunlight by any ordinary photometric device; and having taken this sunlight as nearly equal as possible to that of the insect, though certainly not greater, to let this determined quantity fall on the slit of a spectroscope at the same time with the light from the insect, two spectra being formed one over the other in the same field and at the same time.

The actual doing this is not so easy as it might appear, owing to experimental difficulties connected with the insect, a part of which arises from the fact that its light is not only fitful but unequal, being of very varying intensities when not wholly intermittent.

The simplest way in which the experiment can be performed is perhaps the following:

The insect is placed immediately in front of the slit of a spectroscope, so that the light of its thoracic or abdominal portion falls upon the slit. This forms a narrow spectrum which should be brought into the lower or upper half of the field, the insect being attached to the spectroscopic apparatus in a position as nearly fixed as possible. The spectroscope is now placed with the axis of its collimator in the line of a ray of sunlight cast from a heliostat without. In the path of this ray is a screen with a circular diaphragm covered with ground glass; a lens in front of the slit casts on one portion of it an image of the white circle formed by the ground glass, which image is the same size as the illuminating organ of the insect and forms a spectrum of the same height in the reserved portion of the field. A suitable disposition of lenses placed between the glass screen and the siderostat enables any degree of illumination to be given to the former, from full sunlight to nearly absolute darkness. If the normal spectrum be studied, a grating is selected of such open ruling that the entire visible spectrum of the first order can be seen in the field, but the grating is first so placed that what is seen is not the spectra but the reflected image of the slit, the grating thus acting (at first) the part of a mirror; so that the observer first sees the two circles of light of approximately equal size and brilliancy, one formed by the insect, the other by the sunlight, and the light of this latter, by the arrangement of lenses between the screen and the siderostat is then adjusted so that while remaining of the size of the insect, it is judged to have the same intrinsic brilliancy, or, at any rate, not a superior one.

The essential thing is that a photometric comparison shall be made of the two lights before the spectra are formed, and that under these conditions the sunlight is equal but not superior to that of the insect.

The necessary condition of equality of the two lights from which the spectra are to be formed, having thus been secured, the grating is moved until the two spectra are brought into the field. The result of this direct test is that the solar spectrum when intrinsically of the same brightness, or even when clearly of less brightness than that of the insect, extends somewhat further toward the red and distinctly further toward the violet, the insect light being more intense than that of the sun for equal lights in the green, but ending more abruptly on the violet side.

It may be added that when the insect's light grew brighter the increment appeared to be more in the blue end or as if the average wave-length diminished with the intensity, but there was no opportunity to put this beyond doubt.

Photometric observations in the prismatic spectrum were made previously to the adoption of the arrangement above detailed, the first being on July 1, 1889, using thoracic light. The insect was mounted on an adjustable stand, to which it was attached loosely, so as to give it such freedom of motion as is needed to insure its emitting the light. It was consequently necessary to readjust its position incessantly, and this necessity constitutes a very obvious difficulty. The thoracic light spots are two ovals, each about 2 millimeters by 1.5 millimeters. Their light is not so bright as the abdominal light, but much steadier, and like that, of a decidedly greenish hue. One of these oval spots was placed over the center of a slit, open just enough to receive the light, or about 1.5 millimeters. This slit was in the focus of a glass lens of 8 centimeters aperture and 82 centimeters focus, which acted as a collimator. The prism was a very large one of flint (faces 11.5 centimeters high, 10.5 centimeters wide), whose mounting included an automatic minimum deviation attachment. The observing lens was similar to the collimator, with a low-power eye-piece in whose field was a pair of heavy vertical parallel wires. The whole was mounted on the spectrometer, primarily designed for bolometric measures and fully described elsewhere.*

The observer waited for some time in a wholly darkened room, and to the eye thus rendered sensitive, the visible spectrum, before magnification, was about 2 millimeters high and 20 millimeters long, the parallel wires being distinctly visible in the indigo at a setting of 45 deg. 25 min., corresponding to a wave-length of 0 μ.468, and in the red at 43 deg. 53 min., corresponding to 0 μ.640. The spectrum then was visible from a little beyond *F* to near *C*, or through a range of 0 μ.172. As might have been anticipated from the greenish color of the light, the maximum brilliancy was in the green near *E*, or near wave-length 0 μ 53 † From this point the light fell away on both sides more rapidly than in the solar spectrum.

July 2. A comparison of the spectra of the thoracic and of the abdominal light gave the latter upon the average about double the intrinsic brightness of the former. This was only a crude estimate, but more exact methods under the limited time for experiment would have been useless, owing to the very fluctuating character of the light. In continuation of the photometric measurements of the preceding day on the thoracic light, this was compared with that from the flame of an ordinary Bunsen burner at its greatest luminosity, whose area was limited by a diaphragm to that of the size of the thoracic light. The light from the base of this luminous flame (height of flame about 3.5 centimeters, air shut off at base of burner) gave a continuous spectrum, which in these first comparisons was alternated with that of the insect. The spectra were judged to be equal in the blue and the red, but that of the insect was much brighter in the green. Again, a spectrum being formed from light taken midway between the base and point of the flame was found to be everywhere too bright, but especially so in the red.

July 3. Continuation of photometric measures, but with abdominal light.

				μ	
Wires seen in indigo	45°	29′		0.463	Abdominal light.
" " red	43	47		0.663	Range 0μ.200.
" " indigo	46	56		0.300	Range 0μ.382.
" " red	43	21		0.779	Bunsen burner.

(Luminous flame 4 centimeters high, at point one-third down from top, just within inner and slightly darker cone, seen through hole 2.5 millimeters in diameter.) Under these circumstances the spectrum of the insect's light was in the green a fair match for that of the burner; elsewhere the latter was brighter, but not very greatly so. Since the insect's spectrum was followed through 0 μ.18 with the thoracic light, while with that of the same character, but double the brightness, it was followed only through a very little more, or 0 μ.20, and while at the same time that of a but slightly brighter artificial flame was followed through nearly double or 0 μ.38, it seems probable that the insect's light actually ceases near the given limits, and does not merely disappear from the inability of the eye to follow a diminishing light. While we observe from these first photometric measures that the

* Reprinted, with additional note, from the American Journal of Science, third series, vol. xl, No. 236, August, 1890.

† See results of an investigation by S. P. Langley, read before the National Academy in 1883, and given in Science for June 1, 1883, where it is shown that in the ordinary Argand burner gas flame indefinitely over 99 per cent of the radiant energy is (for illumination purposes) waste.

* American Journal of Science, March, 1888, p. 188.

† In the normal spectrum the maximum has a wave-length 0 μ 57.

insect's spectrum has undoubtedly a decided maximum in the green, we are led to infer that this spectrum is very probably of the nature of a broad band stretching from beyond *F* to near *C where it terminates*, and this very important inference we shall see confirmed later by other and more exact measures.

August 5. Comparison of relative brightness in different parts of spectrum of abdominal light with that from a student's lamp.

A spectrometer supplied with means* for bringing into the same field the spectra of two different lights formed by a Rutherfurd grating of 17,296 lines to the inch (instead of the prism) was employed for this purpose. The upper half of the slit received the insect's light, the lower half a beam from the brightest part of the Argand flame, which had passed through two Nicol's prisms, one of which was attached to a divided circle. The two spectra were then seen in the same field with their edges in exact juxtaposition. In the field of the observing telescope was a slit 1 millimeter wide, subtending not quite 9.5 (minutes of arc), which allowed light having a range of wave-length of about 0μ.01 to pass. The spectrum of the lamp-light was brighter in every part of the field though in unequal degrees till it was diminished by turning the Nicol's prism. The angle through which the prism was turned to produce equality having been noted, the values deduced from the ordinary formula (transmitted light $= l \cos^2 a$, the angle a being 90 deg. when the light is diminished as much as possible by crossing the planes of the Nicols at right angles) are as follows, where the fractions are those by which the brightness of the lamp spectrum at the various points is to be multiplied to produce equality with the insect spectrum.

Part of spectrum corresponding to center of slit at focus of observing telescope.	Blue green very near F.	Green near *b*.	Green near E.	Yellow green.	Citron.	Yellow.	Orange yellow near D.	Orange.
	μ	μ	μ	μ	μ	μ	μ	μ
Wave length.....	0.49	0.51	0.53	0.54	0.56	0.58	0.59	0.60
Brightness.....	0.02	0.21	0.34	0.37	0.24	0.19	0.17	0.09

Owing to the motion of the insect and the varying brilliancy of the light emitted, these figures (each of which is the result of the mean of several trials including at least two measures) still leave much to be desired. The supply of the insects which had been procured and maintained alive with difficulty, however, did not allow of the experiments being further prolonged, nor of the securing a direct comparison with the solar spectrum. The value of each part of the lamp spectrum having, however, been independently determined with all possible exactness in terms of the solar spectrum, we are enabled to exhibit a comparison of the latter with the insect spectrum so as to show them together. It is assumed that the same amount of luminous intensity (i e., energy in terms of vision as determined by purely photometric methods) is taken, whether from the sun or the insect. The subjoined curves show the solar and the insect luminosity throughout the visible spectrum on the preceding assumption of the intrinsic equality, a result which, however, might be liable to a slight correction of the relative places of the maxima if a direct comparison with sunlight were obtained. The important fact, however seems to be brought out almost beyond question that when spectra are formed from two *equal* lights, one from the sun, the other from the insect, the latter's spectrum terminates both at an upper and a lower limit at which the solar light is still conspicuous. The conclusion follows that the insect spectrum is lacking in the rays of red luminosity and presumably in the infra-red rays, usually of relatively great heat, or that it seems probable that we have here *light without heat*, other than that heat which the luminosity itself comprises and which is but another name for the same energy.

Any other supposition would apparently involve the hypothesis that the spectrum, which we have seen end at the red, had a renewal in the invisible infra-red where the main portion of the solar heat and that of all ordinary illuminants is known to exist. Although this last hypothesis cannot be considered to have much weight, and though we are led to agree with previous observers that it may be assumed with much probability that the ordinary invisible heat would, if we had means to observe it, be found unassociated with the fire-fly's light, yet this assumption is itself far from being proof, and in view of the great importance of the conclusions in question, we shall now try whether it be possible to settle the point by thermal measures with the bolometer.

THERMAL OBSERVATIONS.

To give an idea of the amount of heat at our disposition for experiment, and of the actual minuteness of the radiation which proceeds from even the most luminous tropical insect, we may say that if that rate of radiation from a lamp-black surface 1 square centimeter in area which represents the amount of heat necessary to raise 1 gramme of water, 1 deg. Centigrade, in 1 minute, i. e., one small calorie, be taken as unity, then the luminous radiation of the fire-fly's heat, per square centimeter of exposed luminous surface, as we have found, is about 0.0004 calorie in 10 seconds, and the total luminous radiation from the most powerfully illuminating light spot of the insect (the abdominal one) will not exceed 0.00007 calorie in the same time. But a small portion of this could fall upon the bolometer, and that which actually reached it during the time (10 seconds) required for each observation, was sufficient only to affect an ordinary mercurial thermometer having a bulb 1 centimeter in diameter by rather less than 0 deg.0000023, or by less than 1-400000 of 1 deg. Centigrade.

We have just mentioned that the total amount of heat radiation upon which we have to make our investigation represents less than 7-100000 calorie, while that portion of this which falls upon the apparatus would, in the time of one operation, only raise the temperature of an ordinary mercurial thermometer by less than 1-400000 degree, and we have first to notice the difficulty that in case invisible heat exists in company with the light (and it certainly does exist in ordinary emanations from the surface of any living creature independent of phosphorescence) we have, in this minute radiation, heat of two different kinds, both invisible and which it is yet indispensable for us to discriminate.

We are helped to do this by the consideration that while the insect, like any non-luminous one, must emit "animal heat" from all its surface, its general surface temperature is certainly low, since it feels cold to the hand whose greater warmth excites it to shine. This heat then corresponds to a temperature much below 50 deg. Centigrade, and such temperatures must, as we have shown in other memoirs, be accompanied by the emission of waves whose length relegates them to quite another spectral region to that in which the invisible heat associated with light mainly appears. We can then discriminate the rays of this invisible "animal" heat without the formation of a heat spectrum by their inability to pass through a glass which transmits with comparative freedom radiant heat whose wave-length is less than 3μ, the latter including the region where, if there be invisible heat radiated with the light, it must mainly lie.

The heat in the spectral region of the infra-red we are considering, we know in advance must be, if it bear any sort of relation to the light, almost immeasurably small, and in fact it defied at first all attempts to obtain not merely a quantitative measurement, but even any certain experimental evidence of its existence. At last, upon July 24, with the arrival of a new stock of over two dozen insects and with the aid of experience derived from previous failures, these heat measures were resumed. For the first described, the thoracic light is taken.

The insect was placed 125 centimeters from the mirror of 25.4 centimeters aperture and 73.4 centimeters focus, so that its image was formed at 178 centimeters and enlarged about 1.42 diameters, when a small portion of it filled an aperture equal to the bolometer employed, which was selected from the most sensitive of those used in previous researches in lunar heat and had an aperture of 19 square millimeters. By the preceding arrangement of the mirror an image of one of the thoracic bright spots, with enough of the surrounding body to represent an area of about 13 square millimeters, was enlarged to nearly the surface of the bolometer.

Employing all the precautions taught by a multiplied experience, we obtained by a series of exposures of the bolometer to the insect radiation, a series of small but real galvanometer deflections which represent the excess of total heat radiations from the insect over those from a metal plate of a temperature of about 25 deg. Centigrade, forming the background. These heat radiations come jointly from the luminous spot (area 3 to 4 square millimeters) and about 9 square millimeters of the surrounding body. To determine their characters we interposed a sheet of glass* which cut off all the observed heat. The heat from the luminous spectrum and from a spectral region below it extending to about 3μ (30,000 tenth-meters) was known to be capable of passing through this glass. The evidence then is that there is no heat in the spectrum below this feeble radiation from the luminous thoracic region, sufficient to be capable of affecting the apparatus, though this was so sensitive as to promptly respond to the feeble body radiation from the somewhat larger section of the luminous and non-luminous surface.

Continuation on Abdominal Heat.

The insect's light then is unaccompanied (in the specimen subject to this experiment) by any measurable heat, but to make it still more evident that this is due to the absence of heat below the red (body heat not being in question) we now proceed to take an artificial flame, occupying the same area as the radiating luminous part of the insect, and to see whether heat is observed in it. If the flame be no brighter than the insect, and the heat be nevertheless observed in it when the insect heat is lacking, it is obvious that in the latter case none is observed because (sensibly) none is emitted, and this conclusion is reached *a fortiori* when the flame light is less than that of the insect.

July 27. Through a circular aperture 2.5 millimeters in diameter there was passed alternately the total radiant heat, and that transmitted by glass from a nearly non-luminous Bunsen flame, whose luminosity was very much *fainter* than that from the insects. On this day there seemed to be an exceedingly minute deflection averaging ¼ of one division of the galvanometer scale from the total radiation of an equal portion of the abdominal light spot of the insect, while from the flame there was a mean deflection of 177.5 divisions, showing that the total heat radiation from an equal area of a less luminous flame was many hundred times that from the luminous area of the insect.

Glass being interposed, the heat due to this flame radiation fell to 14.5 divisions, or about 8 per cent of the original radiation, showing that of the quality of Bunsen flame heat immediately in question (that above 3μ transmissible by glass) there was still something like 60 times that of the combined body and luminous radiation of the insect in the far less luminous flame. Subsequently, by the use of a lens giving greater concentration, measurable indications of insect radiation above 3μ, and therefore distinct from any possible body heat, were obtained through glass, showing the flame radiation of this quality from an equal area of the same intrinsic brilliancy—i. e., *invisible* heat and of long wave-length, but shorter than 3μ—to be about 400 times that of the insect.

These experiments were repeated with different luminous flames and with different insects on succeeding days. In some of them especially luminous insect specimens were secured, which, with favorable conditions of the galvanometer, gave very measurable deflections on the latter. By a similar use of the glass to that described, it appeared that flames whose intrinsic brilliancy is nearly comparable to that of a point below the middle of the candle flame, and whose total brilliancy is as exactly as possible comparable to that of the insect, give several hundred times the heat of the latter, even if we consider only that quality of heat which is found above 3μ, while if we compare the total radiations, i. e., those directly observed without the use of the glass, the contrast is still stronger.

It follows that the insect light is accompanied by approximately one four-hundredth part of the heat which is ordinarily associated with the radiation of flames of the luminous quality of those which were the subject of experiment. This value is confirmed by other methods which we do not give here. It will conduce to a clearer comprehension of this if we exhibit in a series of curves derived from our observations the spectral distribution of one unit of energy in the gas-flame spectrum; of the electric arc spectrum; of the sun, and of the insect. In all these the abscissæ are the same, the portion between 0μ.4 and 0μ.7 (violet to red) showing the part of the energy utilized in light, while that from 0μ.7 to 3μ shows the part wasted as invisible heat. The energy in each case being the same, the areas are the same, except that owing to the relative importance of the light heat curve only about 1-20 of the latter can be shown in the limits of the plate.

The curves in plate II deal with luminous intensity only, and give no means of drawing those economic conclusions which appear to follow from our experiments and which the curves in plate III supply. These curves (plate III) all exhibit the spectrum on the normal scale, from that easily visible, lying between 0μ.4 in the violet and 0μ.7 in the red, then to 3μ near the limit of the glass transmission. In the case of the first three, representing spectra of the gas flame, the electric arc, and the sun, nearly all the energy lies above 3μ. In that of the gas flame a considerable portion lies below 3μ (and still more in that of the candle flame, if that were shown where most of the energy would lie below 3μ or outside the limits of the drawing). The curves, then, we repeat, represent equal amounts of energy (which without sensible error we may assume to be all exhibited as *heat*) and inclose equal areas.

The total area represents in each case the expenditure of a unit of cost in thermal energy, the area between 0μ.4 and 0μ.7 the proportion of this utilized as *light*, though, as we have stated, the representative of the fire-fly spectrum, only a fraction of this can be shown (owing to the limits of the drawing).

Resuming, then, what we have said, we repeat that nature produces this cheapest light at about one four-hundredth part of the cost of the energy which is expended in the candle flame, and at but an insignificant fraction of the cost of the electric light or the most economic light which has yet been devised, and that finally, there seems to be no reason why we are forbidden to hope that we may yet discover a method (since such a one certainly exists and is in use on a small scale) of obtaining an enormously greater result than we now do from our present ordinary means for producing light.

APPENDIX.

Determination in Calories of the Heat in the Luminous (Abdominal) Radiation of Pyrophorus noctilucus.

The determination is reached by two steps: (1) The calibration of the galvanometer, so as to give the value of its division in calories, and (2) the inference from the observed deflection in divisions of the total of calories radiated.

1. The bolometer, whose face occupied 0.19 square centimeter (a), gave a deflection of 342 divisions (b) at a distance of 25 centimeters (r) from a 5 centimeter circular aperture filled by a blackened Leslie cube. Seen from the center of this aperture, the bolometer occupied, then $\frac{a}{2\pi r^2} = 0.0000484$ of the hemisphere, and would have received this fraction of the total radiation, except that being placed exactly opposite the radiating surface, more than the mean radiation fell on it in a proportion which calculation shows as about 1-3. The fraction of the total radiation which it actually received, then, was 0.0000645 (c).

Accordingly the total radiation would have caused a deflection $\frac{b}{c} = 5{,}300{,}000$ divisions.

The surface of the cube was a temperature of 99 deg. Centigrade, and was limited by the diaphragm to an area of 19.6 square centimeters (d). The total radiation from one centimeter, then, would have caused a deflection of $\frac{b}{cd} = 270{,}400$ divisions. The temperature of the bolometer, which was that of the apartment, was 20 deg. C. According to Dulong and Petit's law the radiation from such a surface at 99 deg. C. to one at 20 deg. C. would be 1.11 cal. per minute (e), which does not greatly differ from our own independent determinations, and for 10 seconds $=$ 0.167 minute (f) (the time of the galvanometer swing) it equals 0.185 cal. (ef). Hence $\frac{b}{cdef} = \frac{270{,}400}{0.185} = 1{,}462{,}000$ div. is the potentiality of work in 1 calorie, to be expressed in the swing of the galvanometer needle, and 1 div. $=$ 0.000000684 cal.

2. The galvanometer received the fire-fly radiation through a lens which occupied 0.00655 of a hemisphere, and would have transmitted this fraction of the total heat, except for its position, which caused it to transmit 1-3 more than the average, which is 0.00873 (g). The measured radiation from this fractional part gave 0.84 div. (h) and $\frac{h}{g} = 96.2$ div. is the deflection which would be given by the total abdominal emission, or

$$96.2 \times 0.000000684 = 0.0000658 \text{ cal.}$$

Since the luminous surface has an area of about 1-6 square centimeter, this corresponds to a radiation of 0.00039 cal. per square centimeter of radiating surface in

* Alluded to but not fully described in the American Journal of Science, August, 1877.

* Described in the Memoir "On the Temperature of the Surface of the Moon," Mem. Nat. Acad. of Sciences, vol. iii, as "B."

the time of the galvanometer needle's swing, or to $\frac{0.0004}{t} = 0.0024$ cal. per square centimeter per minute.

(Taking the water-equivalent of the bulb of an ordinary mercurial thermometer 1 centimeter in diameter at 0.25 gr. we find

$$\frac{0.84 \times .000000684}{0.25} = 0\text{deg}.0000023,$$

showing that if such a thermometer were placed in the position occupied by the bolometer its rise during the time of the latter's exposure to the radiation of the insect would be between two and three one-millionths of a centigrade degree.)

CALOCHORTUS.

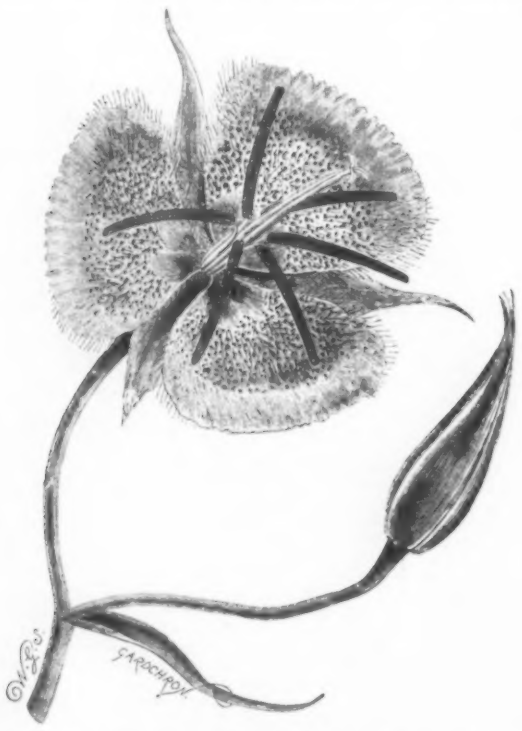
There are few, if any, flowers that surpass in beauty those of this genus and there are few, if any, botanists more capable of dealing with them in a satisfactory way than Mr. Carl Purdy. That gentleman, says Gardeners' Chronicle, has lately issued a revision of the genus Calochortus in the Proceedings of the California Academy of Sciences. The plants extend from British Northwest America to Mexico, and as far east as Nebraska. This vast area entails considerable variation in soil, climate, and altitude; and a corresponding variation in the plants which grow in it.

It is only in the garden, writes Mr. Purdy, where plants from different localities can be grown under identical conditions, that the relationship between apparently different forms can be satisfactorily determined. Mr. Purdy has had nearly every known species under cultivation for some years, and the garden has proved the identity of forms apparently different; here also the variations attributed to environment are shown to be constant. In the garden, too, strains which from a botanist's standpoint seem scarcely distinguishable, showed marked differences in vigor, flowering time, or immunity from disease.

Hundreds and thousands of Liliaceous plants may in one locality be picked showing little or no variation. In another locality the variation is very observable. The difference may be slight, but the "variant" once noted is found to be constant. The difference is generally such as that which florists denote by the term strain, not that which constitutes a species or variety. Mr. Purdy tells us he has seen places where hundreds of flowers of *C. venus'us* could have been selected, each differing in color and markings from the rest. Why a species that remains so true to a type in some localities should vary so remarkably in others, is a circumstance not easy of explanation. Hybridization will account for it in some but not in all instances.

In cultivation, a very slight variability in strain is often accompanied by a marked constitutional difference. In two adjacent beds of *Calochortus venustus* coming from different localities, the differences may be too slight for the botanist's eye to detect. Nevertheless, in the one bed two-thirds of the leaves may be destroyed by mildew (Botrytis), while in the other not a leaf is affected. The extreme types on which species are founded are easily distinguishable, but a perfect chain of variations links them closely together. Thus there is no doubt that *C. Weedii*, *C. Plummerae*, and *C. obispoensis* are variations from one species. Absolute differences of size, dependent as they are on differences of environment, are of little value as points of distinction, but proportionate differences are of more value. Mr. Purdy describes forty species in two sections, each section divided into a number of groups. An analytical key will facilitate the identification of any particular species, a process still further aided by a full description of each species, with appropriate bibliographical references and explanatory notes. Figures of *C. Purdyi*, *longibarbatus*, *luteus*, *Weedii*, and *macrocarpus* are given. The author, supported no doubt by competent authority, adopts the objectionable practice of spelling personal names with a small initial letter instead of a capital, a proceeding which we are glad to see is not followed in the new Supplement to the Index Kewensis. But this is a small matter. Of much greater moment is the fact that Mr. Purdy has laid gardeners, and especially garden-botanists, under great obligations by this publication, which will, we trust, be reprinted in some more easily accessible form than the Proceedings of the California Academy.

CALOCHORTUS PLUMMERÆ (HORT. WALLACE): COLOR LILAC.



CALOCHORTUS LUTEUS VAR. WEEDII: FLOWERS RICH YELLOW.

CALOCHORTUS ELEGANS VAR. AMŒNA: COLOR OF FLOWERS LILAC.

CHOICE OF PHOSPHATIC FERTILIZERS.

M. A. Prenigaud, in considering the choice of potassic fertilizers, says that, although the restitution of potassa is not so absolutely necessary for the soil as that of nitrogen and phosphoric acid, still potassic fertilizers ought to be employed for lands which contain but small quantities of this element. In general these are light lands, calcareous or silicious, and poor in argillaceous matter.

The forms of potassic fertilizers are numerous, and the choice is embarrassing. Usually the cultivator regards only the price, and as potassium chloride is the cheapest that is the one chosen. Though money saved is money earned, often serious disappointment is encountered by considering only the price.

We will attempt to show by a few simple considerations that each form of potassic fertilizer is suitable for certain conditions. The principal are these: Potassium chloride, kainite, potassium sulphate, potassium nitrate and potassium carbonate.

The *potassium chloride* of commerce contains from 48 to 50 per cent of potassa. It is this fertilizer which furnishes the potassa at the lowest rate, the price of the kilogramme costing about 0.40 franc. In presence of the calcareous matter of the soil the potassium chloride yields potassium carbonate and calcium chloride. The latter is hurtful to plants and obstructs the ferments which produce the nitrification of organic matter. But when the soil is permeable and the rain abundant it is rapidly drawn in by the water and has not time for injury. In lands poor in lime it requires a long time for its conversion; meanwhile the development of the plants is impeded and nitrification prevented. It also causes the inconvenience of carrying off the small quantities of lime which the soil may contain. An application of 100 kilogrammes of potassi-

um chloride removes about 67 kilogrammes of calcium carbonate in the form of calcium chloride.

According to MM. Muntz and Girard the average composition of kainite is the following: Potassium sulphate, 24.0 per cent; magnesium sulphate, 16.5; magnesium chloride, 13.0; sodium chloride, 31.0; calcium sulphate, 1.5; water, 14.0 per cent. This product being comparatively poor the kilogramme of potash is loaded with a high cost of transportation, which brings the price to 0.50 franc.

This fertilizer being very high in chlorides presents the same inconvenience as potassium chloride for soils not calcareous. It is more costly, and, therefore, there is no advantage in its employment.

Potassium sulphate contains, like the chloride, from 48 to 50 per cent of potassa, making the cost of the kilogramme of the fertilizing element come to about 0.50 franc.

In calcareous soils potassium sulphate produces double decomposition with calcium carbonate, yielding potassium carbonate and calcium sulphate or plaster. The calcium sulphate is not attended with the same inconveniences as the calcium chloride produced by potassium chloride; on the contrary, it is useful to plants.

In lands poor in lime, in which the carbonate is not sufficient for complete conversion, potassium sulphate has not, like the chloride, the disadvantage of injuring the plants and preventing fermentation in the soil. It has the advantage of occasioning less loss of the lime, the plaster formed being much less soluble than calcium chloride.

Potassium nitrate costs more for the same quantity of potash and nitrogen than these would cost if derived from potassium sulphate and sodium nitrate respectively.

A second objection opposed to the employment of potassium nitrate is the following: This fertilizer contains 44 per cent of potassa and 13 per cent of nitric acid. For obtaining a sufficient quantity of nitrogen a considerable quantity of potash must be buried. This objection has not the same strength as the first, for it is preferable to apply only a part of the nitrogenized fertilizer in the state of nitric nitrogen.* If only 13 to 15 kilogrammes of nitric nitrogen are applied only 44 kilogrammes of potassa are brought in with it, which is a suitable proportion.

This fertilizer, containing only alimentary matter, has the advantage of not being harmful to the plants. Tests with potassium nitrate have shown that vegetation is quite materially promoted by its application.

But notwithstanding its advantages, considering its price, it ought to be employed only for cultivation which furnishes an abundant and valuable product and can consequently bear considerable expense, such as vine and garden cultivation.

The *potassium carbonate* of commerce contains about 60 per cent of potassa. This is the most expensive potassic fertilizer. The price of the kilogramme of the fertilizing material varies from 0.80 to 1 franc. This fertilizer has the advantage not only of furnishing the potash in a state quite favorable for plants, but causes an alkalinity in soils not calcareous, which favors nitrification. Being costly, it ought to be employed only for abundant production on argillaceous lands poor in calcareous matter, which have no need generally of a large quantity of potash.

Having regard to prices, potassium nitrate and carbonate should be employed only in special cases. Kainite and the crude salts of Stassfurt should not be employed in any case, the kilogramme of the fertilizing material being loaded for these products with the cost of transportation, making the price as high as that of potassium sulphate, and they have the additional disadvantage of introducing the chlorides of sodium and magnesium, which are hurtful in soils not calcareous or in calcareous soils not readily permeable. Potassium chloride and potassium sulphate are therefore the only potassic fertilizers suitable for general employment.

In calcareous and permeable lands, like most of those of Beauce, the cretaceous lands of Touraine, the jurassic lands of Bery, potassium chloride can be employed. In presence of calcium carbonate, potassium carbonate is formed, which will be retained by the soil and communicated slowly to the plants, and calcium chloride, which will be carried off by the rain, and thus be harmless.

In the lands of Sologne, which generally contain only traces of lime, employment of potassium chloride will do more harm than good. Here the employment of potassium sulphate is indicated. The case is the same for argilo-calcareous lands, not permeable with facility, in which the rain will not readily carry off the calcium chloride.—Translated from Le Phosphate.

* In distinction from ammoniacal nitrogen; that is, nitrogen derived from ammoniacal sources.—Trans.

THE HANDS OF THE AYE-AYE.

THE aye-aye, says Knowledge, has somewhat the appearance of a large dark-colored squirrel; and in size it may be compared roughly to a cat, the total length being about three feet. The forepaws, or hands, which are unusually elongated, display a most strange peculiarity. As in lemurs generally, the thumb is capable of being opposed to the index finger, which is short; the latter, together with the fourth and fifth digits, being of normal thickness and provided with long compressed and pointed claws. The third, or middle, finger, is, however, quite unlike the others, being extremely thin and spider-like. Clearly these peculiarities must be connected with its mode of life. And we learn from those who have observed the creature in its native forests or in captivity that the aye-aye, unlike the true lemurs, subsists largely upon wood-boring insect larvæ, especially on the larva of a beetle known to the Malagasy by the name of andraitra. Apparently the aye-aye possesses a sense of hearing so acute that when on a bough it can detect the faint rasping sound made by the jaws of the andraitra as it bores its way through the wood in the interior. Thereupon it at once sets to work with its powerful front teeth to chisel away the intervening wood till it opens up the tunnel of the burrowing larva. As soon as the tunnel is opened up the attenuated middle finger is thrust in, either to act as a probe to determine the position of the larva, or to drag it out from its hiding place, or perhaps for both purposes. Some uncertainty still obtains as to the exact details of these and other operations of a like nature, for our information on these points appears to be mainly, if not exclusively, based on native accounts. There is, however, little doubt that the *modus operandi* is in the main as described above. We thus have a sufficient and satisfactory explanation of the reason why the aye-aye differs so remarkably in its dentition and in the structure of its hand from all its living kindred. If, however, we attempt to account for the gradual development of these peculiarities by what is commonly called natural selection we encounter considerable difficulty. It is easy to conceive how the ancestors of the horse may have lost their lateral toes by disuse, but how an ancestral aye-aye gradually reduced the size of its middle finger till it assumed the attenuated proportions of its existing representative is very hard to understand, seeing that a slight diminution in the caliber of this digit would be of little or no advantage. Some much more potent cause than "natural selection" seems necessary in this, as in many other instances.

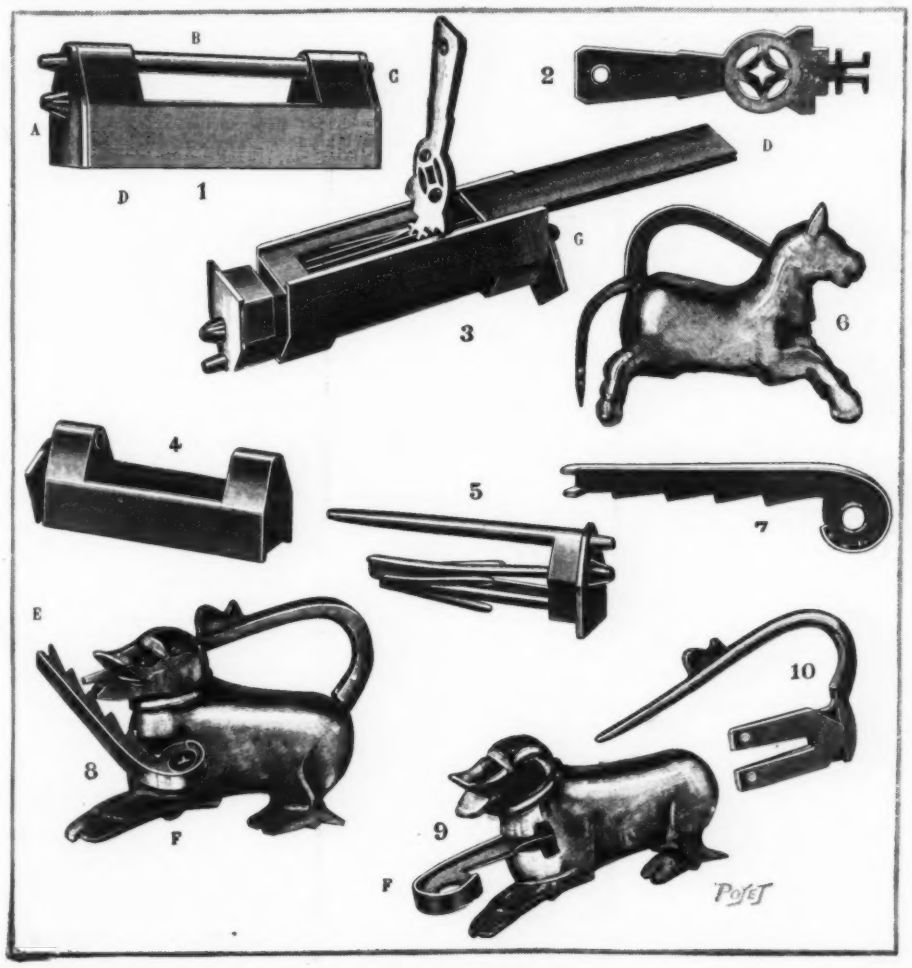
THE PADLOCKS OF INDIAN CHESTS.

IN France, during the middle ages, a sort of trunk called a "bahut" was in current use among the noblemen and commoners. This article was nothing more than a wooden chest set into a sort of osier basket covered with calfskin, which was either entirely plain or ornamented with copper nails arranged in arabesques. Into it were put articles of clothing or other objects. By those fond of traveling, it was used like our present trunks. A little later on, it became also a piece of household furniture. In fact, in those remote times, it served not only as a receptacle for clothing, linen and money, but was used likewise as a table, after being placed upon a tripod, or else as a bench. It was one of the principal pieces of furniture in the house of every private individual. The bahut was generally provided with straps of forged iron, often artistically wrought, and with several locks according to the value of the objects that it contained.

The use of these chests was perpetuated in France up to about the seventeenth century. The lord of Brantome tells us in his writings that at the court of the king and at parties in the houses of the wealthy noblemen, these chests were used by the ladies as seats.

Although the use of this sort of furniture has become obsolete in France, except in the rural districts, such is not the case in India, where the chest, which is certainly very ancient, is still in permanent use.

Like the French of bygone days, the Hindoos employ it either as a traveling trunk or as a stationary piece of furniture in their dwellings. The chest in the latter case is decorated with paintings or is covered with a brilliantly covered fabric. The large Indian chests are not provided with straps and complicated and artistic locks like the French ones of the middle ages, but are securely closed by their owner by means of ingeniously-devised secret padlocks, a few specimens of which, taken from La Nature, are here illustrated.



INDIAN PADLOCKS.

In No. 1 of the accompanying engraving, a closed lock is represented. This, although very ordinary in form, is nevertheless the most complicated of the series. It is difficult, in fact, upon looking at its key (No. 2), to understand how it is necessary to proceed in order to open the lock through the use of this so fancifully-shaped object. To do this, the button, *A*, placed upon the left-hand panel of the lock must be pressed downward. Upon afterward giving a pull, it will be seen that the entire upper part, *B*, although it appeared stationary, can easily be slid. As the copper panel, *C*, forming the right-hand face of the lock is no longer held, it then turns upon itself. This panel, when displaced, permits of pulling out the slide, *D* (No. 3). The internal mechanism of the lock is now entirely exposed, and the part that the mysterious key (No. 2) is to play may be easily understood. It is necessary to fix its extremity in a groove near the panel, and then to give it a strong push in order to expel the essential part of the lock, that is to say, the ingenious combination of small iron rods fixed in the form of an arrow to two strips of copper (No. 5). These perform the office of a spring and are arranged on each side of a grooved axis upon which the key slides. The lock is finally open, and nothing remains in the hand but its last fragment (No. 4). The second lock, in the form of a fantastic horse (No. 6) and the third in the form of a chimera (No. 8) have a key provided with teeth, which terminates at one end in a curved knob.

In lock No. 8 it is necessary in the first place to introduce the key into the aperture formed in the center of the breast of the chimera by its curved end, *F*, as shown in No. 8; and then to turn it until its extremity, *E*, shall have entirely entered in the direction of the axis of the lock, as shown in No. 9. The key is afterward pushed in by bearing upon the end, *F*. As a consequence of this motion, the spring, which is composed of small iron rods arranged in the form of an arrow (No. 10), as in the first case, is entirely disengaged, as is also the tail, the extremity of which traversing the head of the chimera, seemed to form the animal's tongue.

In order to open lock No. 6 with the key No. 7, it is necessary to operate exactly the same as with the one that precedes.—La Nature.

THE MODERN WALLS OF JERUSALEM.

AFTER the disappearance of the Latin feudal kingdom of Jerusalem at the close of the thirteenth century, and the extension of the Egyptian Mohammedan government in the Levant, the famous city seems to have sunk into a very unimportant condition; no monuments of any size or architectural character can be attributed to the fourteenth and fifteenth centuries. According to the Builder, the Christians must have been content with such ruins as they were permitted to occupy, and the Egyptians have left very few traces of their presence in the Holy City. This may partly be accounted for by the fact that during these centuries the capital of the district was once more constituted at Ramleh, on the great caravan route by Gaza, where, in the days before the Crusaders, the Ommayedes had founded their center of government. At the beginning of the sixteenth century Ramleh was falling into the decay in which we now see it, and Jerusalem was restored as a walled city, after two centuries of ruin. The "Aksa" or principal sanctuary

of the "Haram" inclosure (this inclosure, occupying the ancient acropolis of the city, is usually known as the "Mosque of Omar") is probably the only monument of any size erected by the Egyptian government. According to an inscription it seems to have been built, or rebuilt, by the Mamluke Sultan Mohammed *ibn Kalaun* in 1327. It is merely a very poor attempt to copy a Christian church; the materials are all second-hand, and the mode of construction and the few attempts at ornament are probably among the poorest and meanest examples of the Mohammedan style. At the north end is an arcaded porch recalling the design of a common Cairene type of mosque of the period. As an example of Saracenic architecture it is beneath criticism. One or two small monuments scattered about the Haram without order or arrangement also date from this time.

With the beginning of the sixteenth century came a very great change in the condition of Jerusalem. The Osmanli Turks, in the extension of their immense empire, took possession of Palestine, and one of the most important monuments of the reign of the first two Turkish rulers of Palestine is the singular, and in some respects magnificent, wall erected round Jerusalem. This imposing work evidently dates from the commencement of their rule in 1517, as the inscriptions on the north side of the city record the name of Selim I. Suleiman II., his successor, is perhaps to be credited with the greater portion of the work and its completion. The dates on mural tablets inserted in various portions of the wall range over a period of about twenty-five years. At this time the Ottoman Empire was attaining its most splendid development, and the retreat of the Knights of St. John from Rhodes in 1522 marks perhaps its greatest victory over the western nations. Fifty years later the battle of Lepanto put an end to all Turkish advance westward, and heralded the decay which is associated with the Turkish name at the present day.

The innumerable voyages, travels and histories written by pilgrims of the sixteenth century on their return from their perilous journey to the Holy Sepulcher naturally contain many references to this then new wall. These worm-eaten volumes may be found on the dusty shelves of all the older European libraries, and a few extracts from them will suffice to give some idea of the Holy City in those days.

Ludovico degli'Agostini, of Pesaro, wrote an account of his pilgrimage about 1550 for the Duke of Urbino. He describes the new wall of Jerusalem as the finest to be seen in the whole world. It was built of fine white stone properly squared, and decorated with merlins and many turrets, etc. As in many Turkish cities, there was also a fine castle which reminded him of that at Ferrara. The wall was built by Sultan Suleiman, in accordance with his father Selim's intention, as an *ex voto* to the holy Mohammedan city. Selim, in his victorious progress through Syria on the way to Egypt, had camped outside near the gate of St. Stephen, or Bab Sitti Mariam, and here he meditated the complete destruction of Jerusalem. But his intentions were changed in consequence of a dream in which he seemed to see the Holy City being devoured by two lions. Instead of destroying it he determined on surrounding the holy places with the present magnificent wall; but he seems to have desired it should not be prepared for artillery. Before leaving Jerusalem he presented rich gifts to the inhabitants, including the Christian communities. The story of the vision of two lions is supposed to be commemorated in the two very conventional attempts to represent such animals which may be seen over the arch of the Bab Sitti Mariam. The Sultan's decision not to regularly fortify the town originated in the policy of previous Mohammedan rulers, who, for fear of having a strong fortress within their borders, which the Christians would desire to secure, had always destroyed the mediæval walls whenever they became masters of the city.

In the middle of the sixteenth century Jerusalem was supposed to contain 15,000 inhabitants within the new wall, which was about three Italian miles in circuit. The guard, called "Tambracano," was changed every six hours to the sound of drums and fifes, and this served for a sort of clock in addition to the call of the muezzin from the minarets, bells being, of course, out of use.

The Seigneur de Villamont, who visited Jerusalem in the latter half of the sixteenth century, was surprised to find the city gates without any *pont-levis* or outworks. At the entry of the château were a number of cannon, some in bronze, others in iron, "qui sont braquées pour la défence de la porte." The château was of great extent, similar to those in Italy, but "sans aucunes tours, fors une bien haut élevée, et en forme de donjon, qui sert pour faire la sentinelle." Evidently this château, or "Castrum Pisanum," as it was known all through the Middle Ages, has been added to since the sixteenth century, for at the present day there are two or three very distinct towers in its construction.

Quaresimus, "Guardian of Mount Sion," at the beginning of the seventeenth century, hardly mentions the city wall in his voluminous "Elucidatio Terræ Sanctæ." He merely states its having been built by Suleiman, and the legend that the architect had his head cut off at the conclusion of the work (a convenient mode of settling his commission), because he had excluded the portion of Zion on which the Cenaculum stood. Quaresimus also gives the Hegira dates, which were inserted at different points on the wall in small stone tablets, as follows:

St. Stephen's Gate	(A. D. 1516)	A. H. 921
Gate of Flowers	(A. D. 1539)	A. H. 944
Damascus Gate	(A. D. 1539)	A. H. 944
Sion and Dung Gates	(A. D. 1542)	A. H. 947

The materials were partly quarried for the purpose, but Christian buildings furnished the greater part. The Minorites were expelled from the Mount Sion Convent in 1549 (Gesta Dei per fratres Minores), but they only occupied the modern convent of S. Salvator in 1559.

Francis I., King of France, seems to have exerted himself on behalf of the dispossessed Minorites, and an interesting brief on the subject addressed to him by the Sultan Suleiman has been published in various books on this chapter of history. The Jews were accused of intriguing with the Mohammedans to turn the Franciscans out of the Cenaculum, who, after their expulsion, were condemned to remain outside the city for years, exposed to the attacks of Arab marauders.

The voyage of the French Ambassador, M. d'Aramon in 1547 contains some references to Jerusalem. His arrival outside the walls of the city is described, and the way in which he was met by all the notables, escorted by a large body of arquebusiers. The city is described as having been inclosed with walls by the Turks, but its aspect seems to have been disappointing. The streets being uninviting and apparently in ruins, the arcades, which had anciently covered them and permitted of one's passing about the city dryshod in wet weather, had fallen down. The market was near the Porta Speciosa. M. d'Aramon seems to have been chiefly impressed by the ruinous condition of the interior of the city.

An old semi-devotional description of the Holy City at this period was written by Fra Bonifazio Corsetti in 1553. It is called "Liber de perreni cultu Terræ Sanctæ," and contains some curious particulars. From this it would appear that the ancient wood doors of the Golden Gate were removed at the time of rebuilding the walls, and they were presented to the Franciscans as a relic, and placed in the collection of relics preserved in the Church of the Holy Sepulcher. About this time the annual commemoration of Christ's supposed entrance by the Golden Gate, which was celebrated by a procession of the Franciscan monks from Bethphage to the Cenaculum through the valley of Jehosophat, was discontinued.

A sort of guide-book for pilgrims, written by Fra Noe, of the Franciscan Order, of uncertain date, but apparently of about the middle of the sixteenth century, states that nothing remained of ancient times except the Golden Gate and some antiquities in the church of the Franciscans of the Cenaculum. The only important fragment of earlier Jerusalem left in the course of reconstructing the mediæval walls in 1516-1542 was the Golden Gateway. This most interesting late Roman monument does not come within the range of the present notice, except in as far as it affords a singular contrast with the characteristic mode of constructing gateways of Levantine cities during the Middle Ages. The old Roman gateway was with two side-by-side archways, with a straight cut through the wall, much in the way of the gates of Aurelian's wall round the capital. In the sixteenth century the Turks had a very different mode of constructing the entrances to their castles and cities. Rey, in his "Colonies Franques de la Syrie," draws attention to the great difference in style of design between the Christian and Mohammedan fortresses, and it is curious to find that which he identifies with the Mohammedans (and also with the buildings of the Order of the Temple) surviving at a period about three centuries after the Crusades. In nothing is this curious survival more noticeable than in the mode of constructing the city gateways. In the Mohammedan style the gateway, instead of being a simple archway defended by one or more portcullis, a drawbridge over a moat, a barbican, etc., as in European fortresses, is always planned on a crooked principle, by which the assailants, after forcing the outer gate of wood and iron, found themselves inside a vaulted passage turning either to the right or left, at the end of which was another heavily constructed gate. By this system the assailants were trapped in a small space and at the mercy of the defenders of the fortifications, who could kill them off through loopholes arranged for the purpose. It will be noticed that all the gates of Jerusalem except the "Golden Gate," which was preserved by the Turks as traditionally built by Solomon the Wise, are planned on this principle, a system evidently found sufficient for the purpose of eastern warfare before the introduction of more scientific gunnery in the seventeenth century. Such a plan for a gateway almost prohibits the entrance of wheeled vehicles into a town, and until the last few years, when the Bab Sitti Mariam and the Jaffa Gate were altered for the purpose, Jerusalem was almost impracticable for carriages, the only entrance to the city large enough for such a purpose being the Damascus Gate, which still remains in the condition in which it was first built, and still affords an opportunity for the Arab "Arbughi," or coachmen, to display their skill in turning corners with the modern carriages, which nowadays have taken the place of horse litters. All the gates of Jerusalem are decorated with scraps of mediæval carving gathered from the ruined Christian churches, and used up in a meaningless manner. Capitals of columns stuck into the walling as brackets, archstones over windows which they do not fit, and odds and ends scattered about on the principle of shell grotto architecture, have a grotesque appearance. Such ornaments as seem to have been cut expressly for the position they occupy are of the most meretricious character. And here it may be noted that all over the walls as well as on the gateways a feature presents itself peculiar to the Levant. In the true mediæval fortresses it was the custom to utilize the granite, marble, and stone columns of the old Romano-Greek cities such as Cæsarea, Jerusalem, Askelon, etc., as bond stones in the thickness of the walls. They seem to have been specially adapted to resist the effects of mining and battering. In the sixteenth century walls of Jerusalem this older style of construction has been imitated with a very curious result. But at this period the supply of columns must have come to an end, or the mere appearance of such a system of building was thought sufficient, and so Suleiman the Magnificent was content with a series of round *pateræ* dotted over the surface, each one of which is generally carved with a different design of the usual interlacing Arabic style, and slightly projecting from the wall to represent the section of a column. The result is as unsatisfactory as such a tawdry sham might naturally be expected to produce, and adds to the unreal character of the work as fortifications.

Jerusalem, since the middle ages, has never been provided with any regular trenches or other usual elements of fortification. Merely this imposing wall, three miles in length, and of an average height of about 30 feet, has formed for three centuries and a half an inclosure to the Holy City. Since it was built the city has only once been subjected to a hostile attack, and that from the very Turks who built its walls. In 1825 the inhabitants endeavored to resist an impositior of taxes, but were quickly persuaded in the matter b a slight bombardment.

THE EASTERN INTERIOR COAL FIELDS.

ILLINOIS ranks, next to Pennsylvania, second in the list of coal-producing States of the country; and it contains more than three-fourths of the entire area of the Eastern Interior coal field. This coal field, as we are told by Mr. George H. Ashley in Part III. of the Twenty-second Annual Report of the United States Geological Survey, now in press, occupies 80 counties, 35,000 square miles, in Illinois; 26 counties, 6,500 square miles, in southwestern Indiana; and 20 counties, 4,500 square miles, in western Kentucky. Of these counties, coal is now mined in 58 in Illinois, 21 in Indiana, and 11 in Kentucky. The structure of this field is that of an elongated basin, whose lowest portion is in southeastern Illinois. In Indiana, the cannel coal of Cannelburg, the "Indiana block coal," and the semiblock coals, lying in small basins, cover central Fountain and Parke counties, nearly all of Clay, western Greene, practically all of Daviess, Dubois, and Spencer, the eastern portions of Pike and Warren, and western Perry. Very thin between the basins, the coals attain a thickness of from 3 to 5 feet in the center of each basin. What is commonly called the bituminous field in Indiana covers that portion of Indiana lying west of the block coal field. It is found in Vermilion, Wabash, Vigo, Sullivan, Knox, Parke, Clay, Greene, Warrick, Gibson, Vanderburg, and Posey counties in beds averaging probably 6 feet in thickness. The workable coals of Illinois underlie vast areas in beds of from less than 3 to about 10 feet in thickness, and so near the surface that in very many instances the coal is mined by stripping. Beginning with the Danville field, Vermilion County, on the northeast, these fields are north in Will County, thence west to Rock Island County, on the Mississippi River, and thence southward embracing practically all the rest of the western, central, and southern parts of the State. There remains a large area in the eastern part of the State, from Kankakee County to White, Vermilion excepted, in which the workable coal, if, as is likely, such exists, lies probably from 300 to 500 feet deep. In Kentucky the coal of this field, in beds averaging probably 5 feet, occupies the whole or parts of seven or eight counties lying in or near the angle of the Ohio and the Tennessee rivers; Hopkins, Webster, McLean, Muhlenberg, Hancock, Henderson, Union. These beds lie comparatively near the surface. As compared with the averages of Indiana and Illinois coal, it would appear that the Kentucky coal was richer in fixed carbon, but poorer in gas, and with a greater quantity of ash and sulphur. Most of the western coals run high in gas, which puts them to a disadvantage in actual present practice as compared with coals of the Appalachian field, having about the same total amount of combustible matter. As to their coking value, a study of the statistics of coke production in Indiana and Illinois shows that those States are not succeeding as coke producers. On the other hand, the production in Kentucky has risen from 2,223 tons in 1884 to 72,975 tons in 1900, of which 36,864 tons were produced in the western field. The difficulty in Indiana and Illinois seems to be that the purest coals are of the splint or non-coking variety, and that the coking coals run too high in sulphur. By way of summary, the coals of the Eastern Interior field have not proved to be satisfactory for the manufacture of gas, except where they have great advantages in freights over Pennsylvania coals; the same is true of coke in Indiana and Illinois. The coke from western Kentucky coal is of excellent quality, and is finding an ever-increasing market. For steam production the coals of this field do not fall far behind the best eastern coals, and they are probably as good or better than most of the coals from fields farther west. The history of coal in this region takes us back to the picturesque, not to say romancing, figure of Father Hennepin near Fort Creve Cœur on the Illinois River in 1698. His is also the first mention of coal found in America. In 1763 coal was noticed on the Wabash River by Col. Croghan. In 1811 coal was dug at Fulton, Perry County, Indiana, and taken aboard the steamboat "Orleans" by Robert Fulton, on his first trip down the Ohio River. 1840-1850 considerable coal shipped down the Ohio from Kentucky, and from points along the Wabash, White, and Ohio rivers in Indiana. 1850-1860, extensive coal mining in Illinois. 1879, Illinois third, Indiana fifth, Kentucky ninth in rank as coal producers in the United States. In 1900 Illinois was second, Indiana sixth, Kentucky seventh in rank. In all three States the room and pillar method of mining predominates, and in all three also machines are largely used in mining the coal. In Illinois and Indiana the large majority of miners are white, the colored miners having in the main been brought in to take the place of strikers. In Kentucky a large proportion of miners are negroes. Of the white miners in Indiana and Kentucky the figures indicate that about one-half are foreigners, and that this proportion is on the increase. The Eastern Interior field supplies entirely or in part the fuel market for all of Indiana west and south of the Indiana gas field, all of Illinois, western Kentucky, western Tennessee, northwestern Alabama, Mississippi, points in Louisiana and Arkansas on the Mississippi River and its tributaries, eastern Missouri, eastern Iowa, and portions of eastern Nebraska, Minnesota, the Dakotas, and Wisconsin. Its coal comes in competition over the whole of this area with both anthracite and bituminous coal from the Appalachian field both by rail and by water. The production of this field in 1900 was, in round numbers, 35,300,000 short tons, valued at $36,200,000, of which Illinois produced 25,750,000 tons, Indiana 6,500,000 tons and Kentucky 3,000,000 tons; and of this product over 31 per cent was consumed as railroad fuel, 1.5 per cent as steamboat fuel, about 34 per cent as manufacturing fuel, over 32 per cent as domestic fuel, and less than one-half of 1 per cent in making coke. Only one mine seems to be exporting coal—the Wheatcraft mine, Webster County, Kentucky, is shipping to Mexico via New Orleans. Nearly the whole product of this field is shipped by rail. In Illinois 33 roads transport

the coal product, of which 15 carry over 500,000 tons each; in Indiana 10 railroads, and in Kentucky 3 roads carry most of the coal.

In 1900, 87 counties had 799 commercial mines which actually produced over 35,000,000 short tons, and whose estimated productive capacity is over 75,000,000 tons. Over 60 per cent of these mines report prospective increase in production. From these reports it is evident that the prospects for enlargement all over the field are excellent.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Temporary Admission of Wheat into France.—The important questions involved in the proposed modification of the régime governing the temporary admission of wheat into France have been settled by the promulgation by the President, on February 4, of the new law, which had been approved by the Senate and the Chamber of Deputies.

Under the terms of the old law, an exchange of money was not essential to secure a certificate of importation. Upon the arrival of foreign wheat in the bonded warehouses, a certificate of importation was issued, and the wheat itself was cleared for consumption without payment of duty, upon the delivery into the bonded warehouses of an equivalent quantity of the manufactured product of other wheat. The whole transaction became a matter of bookkeeping, and the certificates in the hands of importers had a fluctuating market value, as they could be transferred to exporting millers. Thus, the importer who was expected to pay 7 francs per 100 kilogrammes ($1.35 per 220 pounds) upon foreign wheat, after selling the certificates for from 1 to 3 francs (19.3 to 57.9 cents), was practically enabled to defeat the tariff law to just the amount for which he disposed of his certificate upon the market. Under the new law, only the actual exportation of the merchandise will be considered justification for the reimbursement of the certificates, and the amount of the duty must in all cases be paid in cash upon the arrival of the wheat.

The wheat and flour trade is deeply concerned about the new law, as methods of evading its terms have been suggested and will doubtless be passed upon by the courts in due time. If the trafficking in the certificates of importation is effectually prevented by the law, the effect will be to stiffen the market prices of wheat in this country. Translation of the important articles of the new act follows:

"Article 1. The régime of the temporary admission of wheat organized by the laws of July 5, 1836, and January 11, 1892, is modified as follows:

"The amount of the import duties upon foreign wheats presented for temporary admission must be covered into the treasury at the moment of admission. Upon the direct delivery of such wheats into the mills of the importing miller, an untransferable certificate of importation will be delivered, the amount of which will be reimbursed by the customs officers in proportion to the quantities of flour, semolina, bran, and alimentary products derived from the wheat imported and enumerated in article 2, which shall have been exported after the creation of the certificate of importation, and according to the rate of compensation actually in force or which shall be established hereafter by decree.

"Article 2. The amount of duty paid will be definitely acquired by the treasury in the event of failure of reexportation of flours, semolina, and brans by the importer within two months following the delivery of the certificate of importation."

This delay may be extended to four months, when the importing miller shall have, before the expiration of two months, established to the satisfaction of the customs officers, who shall proceed to the verification of the products, the transportation of semolina or of flour manufactured in his mills to a manufacturer of alimentary pastes, sea biscuits, or sweetened biscuits. Said manufacturer will thereupon indorse upon the certificate of importation the delivery of the product of his manufactory, the exportation of which in manufactured form will permit the reimbursement of the duties paid. The reimbursement of customs duties shall take place only in the case of products forwarded directly from mills or manufactories to the port of departure. These reimbursements shall take place within three days from the delivery of the certificate of importation to the bureaus of emission.

"Article 3. The re-exportation of flours, semolina, brans, and alimentary pastes derived from pastes may take place from all the bonded warehouses and through all the bureaus open either to the transit or entry of merchandise paying more than 20 francs per 100 kilogrammes ($3.86 per 220 pounds).

"Article 4. The delivery in bonded warehouse of flours, semolina, bran, and alimentary products derived from wheat which shall have given occasion to a certificate of importation will not be considered as an exportation.

"Article 5. The manufacturer, accepting terms heretofore laid down, will be required to enter the imported wheats directly into his mill or factory. He will be obliged similarly to deliver the manufactured products intended for exportation directly either to the bureaus of the ports of departure or to the manufactory of alimentary pastes, according to the exception laid down in paragraph 2 of section 2. The customs officers shall have the right to control all of these operations."

The remaining articles of the law provide penalties for false declarations, repeal former enactments governing the same subject, and extend the new law to Algeria.—Robert P. Skinner, Consul-General at Marseilles.

The Indigo Market in 1901.—According to the report of a Hamburg-Calcutta firm, the year 1901 witnessed a slow but steady increase in the prices of natural indigo, with a relatively satisfactory business. Toward the end of summer, however, the demand slackened, due in a measure to the fact that the large color works of Höchst u. Ludwigshafen offered artificial indigo at greatly reduced prices, in order to reduce its stock.

The report calls attention to the wisdom of giving preference to the natural product when prices are satisfactory, and states that should producers be compelled to discontinue the cultivation of indigo on account of its unprofitableness, consumers would become entirely dependent upon the color manufacturers, who would probably combine and raise prices, as was done in the case of alizarin blue.

Owing to the improved method of production, natural indigo will at least remain an equal rival of the synthetic product, and advices from Calcutta regarding the new crop quote prices which will allow the natural product to successfully compete with the artificial.

The finer qualities of Bengal indigo were again least affected by fluctuations of prices. The limited supply found a ready market. The greatest demand was for medium qualities, and the stocks have been much reduced. Java indigo maintained its preferred position and brought relatively high prices. Of the new crop, a considerable quantity is said to have been already sold at high prices for future delivery.

The stock on hand in Europe amounted to 9,000 cases at the end of the year 1901, against 8,500 cases in 1900, 10,000 cases in 1899, 13,500 cases in 1898, 19,000 cases in 1897, and 14,000 cases in 1896.—Walter Schumann, Consul at Mainz.

Hungarian Production of American Fruits and Plants.—A new order of the Royal Hungarian Ministry of Agriculture, prohibiting the import of American plants and fresh fruit, was published yesterday, under date of the 10th instant. I inclose translation. The Hungarian Government lately opened a chemical inspection station at Fiume, in addition to the five stations already in existence. These stations examine the seeds, plants, and fresh fruit brought for import into Hungary. The order of April 20, 1898, prohibited only plants, while the present order prohibits fruit as well. —Frank Dyer Chester, Consul at Budapest.

ORDINANCE OF THE ROYAL HUNGARIAN MINISTRY OF AGRICULTURE IN THE MATTER OF RESTRICTING THE IMPORT AND TRAFFIC IN AMERICAN PLANTS.

Ordinance of the Royal Hungarian Ministry of Agriculture, No. 6094, 1902, in the matter of restricting the import of and traffic in American plants.

I. To the several economic, botanic, and pomological societies.

II. To the several agricultural commissions (city and county).

Of late, the number of petitions addressed to me by individuals and societies for license to import plants, parts of plants, bulbs, etc., of American origin has much increased.

All these petitions allow me to suppose that the interested public is insufficiently informed of the prohibitory order issued under No. 25,000, 1898, in the matter of regulating the traffic in plants of American origin.

For this reason, I call upon you to take measures within your jurisdiction to the end that growers and merchants, in order to avoid any damages, may be properly informed of the contents of the said ordinance.

Under the Government order referred to, which was issued in conjunction with the Imperial and Royal Austrian Government, the import from America of living plants, grafts, layers, and every sort of plant section in a fresh condition, as well as of barrels, boxes, or any other objects of whatever name serving to pack the above-named articles or plant sections, is forbidden.

Likewise, the import of every sort of fresh fruit, fresh-fruit sections, and fruit parings, as well as of objects used to pack the same which originate from America, is forbidden.

This prohibitory measure having been meant to prevent the introduction of injurious insects and of parasites which have appeared in America and the Far East, and are threatening fruit production with annihilation, and hence to preserve home interests of prime importance, I call upon you to endeavor within your jurisdiction to bring about the complete execution of this order.

I call upon you further to send me an immediate report, for the purpose of taking retaliatory measures, in or of all such cases which may come to your knowledge where it may be supposed that there is such elusion and evasion of the prohibition contained in the ordinance, whereby individuals transship by rail plants ordered from America in European states which do not resist American import.

Dated at Budapest, January 10, 1902.

American Surgical Instruments in Switzerland.—I believe there is a market for American surgical instruments in Switzerland. Statistics show that these articles have never been imported into this country, and I am informed by local dealers that there is at present a good prospect for their introduction.

In a recent conversation with the writer, Dr. Egli-Sinclair, an eminent physician of Zurich, who resided for many years in the United States, expressed surprise that so far no attempt had been made by our manufacturers to introduce these instruments into Switzerland, his opinion being that they would undoubtedly meet with a ready sale, as they were admittedly the best in the world. Our dental instruments are largely imported and, in fact, are used exclusively by Swiss practitioners.

I give below a list of the names and addresses of firms dealing in scientific instruments in Switzerland, and will be glad to furnish additional information upon application.

The best plan would be for our manufacturers to send an agent here, with an extensive line of samples; but if this is not convenient, catalogues might be effective, provided they are in the German or French language.

Herrn Baeuerle-De Witt, Chirurgische Instrumente, Basel.

Herren Knoebel & Lauscher, Chirurgische Instrumente, Basel.

Herrn I. Möschinger, Chirurgische Instrumente, Basel.

Sanitätsgeschäft Hausmann, A. G.

Monsieur C. F. Schneider, Instruments de Chirurgie, Geneva.

Dr. N. Gerber, Chirurgische Instrumente, Zurich.

Herren Hanhart & Ziegler, Chirurgische Instrumente, Zurich.

Herren P. A. Koelliker & Co., Chirurgische Instrumente, Zurich.

Herrn E. Lamprecht, Chirurgische Instrumente, Zurich.

Herrn G. Debrunner-Frey, Chirurgische Instrumente, Frauenfeld.

Herrn M. Schaerer, Chirurgische Instrumente, Berne.

—Henry H. Morgan, Consul at Aarau.

German Chambers of Commerce Forbidden to Give Information.—A recent law enacted by the Saxon Landtag (Parliament) prohibits the Chamber of Commerce and Export Association of Dresden and all similar business associations in Saxony from giving information of any character to the representatives of any foreign country.

This measure is so stringent, and its terms are so strictly enforced, that when, on a recent occasion, I went with letters from merchants in the United States asking where they could purchase certain kinds of goods, the secretary of the chamber of commerce declined to give me the names of manufacturers, but was willing to send a copy of the letter to those located in this consular district, with a view of having them correspond direct with the writer.

It will doubtless be difficult and sometimes impossible, in future, to answer many of the inquiries that reach this consulate from the United States.—Charles L. Cole, Consul-General at Dresden.

Foreign Physicians and Dentists in Brazil.—Under date of February 1, 1902, Consul Kenneday writes from Para:

There is a federal statute in Brazil which provides that all physicians, surgeons, and dentists of foreign extraction who desire to practice their profession in any part of the country must first pass a prescribed examination at the medical colleges at Bahia and Rio de Janeiro. These examinations, which include languages and other branches not usually found in a medical curriculum, are said to be so severe that few foreigners have any chance of passing them successfully. It is now reported that this law is to be more rigidly enforced hereafter, especially in the case of dentists. There are several American dentists in Para who have been practicing here for years. They may now be required to go to Rio de Janeiro and take examinations, and in case of failure they will be compelled to give up their profession or leave the country. Although this is a very profitable field for medical practitioners, it should be remembered that the examinations are so severe as to necessitate two or three years' extra preparation.

German Market for American Hats.—Stiff felt hats of modern shapes, in black and brown, with light, tan-colored sweat bands (no dark colors), fancy white satin linings, with gold-stamped designs, and good black ribbon bands, selling at about $12 per dozen c. i. f. Hamburg or Bremen, will find a ready market in Germany. A local dealer informs me that particular attention should be paid to a fancy "get-up" rather than to quality. Straw hats with high crowns and straight, stiff rims, costing from $6 to $9 per dozen wholesale c. i. f. Hamburg or Bremen, will also find a remunerative market. The foreign hats sold in Stettin are of French or English make, stiff hats retailing at from 5 to 9 marks ($1.19 to $2.14) and straw hats at from 2 to 5 marks (47.6 cents to $1.19).

An attempt to deal direct with the retailer would prove unprofitable, as dozen-lot orders would be very common. The business should be placed in the hands of agents, with either Hamburg or Bremen as the principal distributing point. Letters addressed to this consulate will be handed to a gentleman who desires to secure such an agency.

The German import duty on hats is as follows:

		Marks.	
Men's felt hats, trimmed or untrimmed	per 100 kilo.*	180.00	= $42.80
Straw hats:			
Trimmed	each	.40	= .094
Untrimmed	do	.20	= .047

* 220.46 pounds.

—John E. Kehl, Consul at Stettin.

United States Railway Supplies for Nicaragua.—Consul Donaldson, of Managua, writes, January 11, 1902, that the Nicaraguan government has signed a contract (dated December 15 last) with Mr. P. W. Chamberlain, an American engineer, to purchase 300 tons of steel rails and other fittings for the Atlantic Railroad, which the latter is constructing. It is stipulated in the contract that the above-mentioned material is to be purchased in the United States.

The consul adds that Mr. Chamberlain is at present pushing to completion the work on that part of the road connecting the Indio River with the San Juan River at San Francisco, from which point there is steamboat navigation.

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No. 1286, March 11.—*American Surgical Instruments in Switzerland—Foreign Uses of Oil Fuel—The Hat Industry of Monza, Italy—*Steamship Connection between New York and Greece—*Dutch Excise on Wine Used for Cognac—Lime and Sand Stone Building Bricks.

No. 1287, March 12.—Trade and Commerce in Abyssinia—A Turbine Yacht in Scotland—Olive Crop of Andalusia *Trade Openings in Lourenco Marquez; Correction—German-Chilean Commerce.

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The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

SELECTED FORMULÆ.

Sirup for the Fountain.—

Lemon.

Concent. lemon sirup	8 ounces
Solution citric acid	2 ounces
Gum foam	2 drams
Simple sirup, q. s. make	32 ounces

Vanilla.

Tincture vanilla	4 drams
Solution caramel	4 drams
Gum foam	2 drams
Simple sirup, q. s. make	32 ounces

Sarsaparilla.

Essence of sarsaparilla	3 drams
Solution caramel	1 ounce
Gum foam	2 drams
Simple sirup, q. s. make	32 ounces

Raspberry.

Black raspberry juice	8 ounces
Gum foam	1 dram
Simple sirup, q. s. make	32 ounces

It may be necessary to add a little cochineal coloring to this to have the glass of soda the right shade.

Strawberry.

Strawberry juice	8 ounces
Cochineal coloring	2 drams
Gum foam	1 dram
Simple sirup, q. s. make	32 ounces

A good strawberry flavor is one of the hardest to get, and one of the most unsatisfactory. Still, it is not advisable to be without even a poor article.

Ginger Ale.

Soluble ext. ginger	1 ounce
Tincture capsicum	15 minims
Concent. lemon sirup	4 ounces
Extract vanilla	1 dram
Solution citric acid	1 dram
Gum foam	2 drams
Simple sirup, q. s. make	32 ounces

Orange.

Concent. orange sirup	8 ounces
Solution citric acid	1 dram
Gum foam	4 drams
Simple sirup, q. s. make	32 ounces

Grape.

Grape juice, Concord grape	16 ounces
Simple sirup	16 ounces

Draw in mineral water glasses. Use about 1½ ounces of the sirup in an eight-ounce glass.—Prac. Drug.

Banana Sirup.—Cut the fruit in slices and place them in a jar; sprinkle with sugar and cover the jar, which is then enveloped in straw and placed in cold water and the latter is heated to the boiling point. The jar is then removed, allowed to cool, and the juice is poured into bottles.—Prac. Drug.

Banana Cream.—

Shaved ice	¼ tumblerful
Banana sirup	2 ounces
Cream or milk	8 ounces

Shake well, add a few pieces of banana, and fill with soda water.—Prac. Drug.

Egg Lemonade.—

I.

Break one egg in a soda glass, add 1¼ ounces of lemon sirup, a dram of lemon juice and a little shaved ice; then draw carbonated water to fill the glass, stirring well.

II.

Shaved ice	½ tumblerful
Powd. sugar	4 tablespoonfuls
Juice of one lemon.	
Yolk of one egg.	

Shake well, and add carbonated water to fill the glass.—Pract. Drug.

Pineapple Sirup.—

Essence of pineapple	2 ounces
Sol. citric acid (50 p. c.)	1½ ounces
Simple sirup	1 gallon

—Pract. Drug.

Raspberry Sirup.—

Raspberry juice	32 ounces
Granulated sugar	3½ pounds

Dissolve the sugar in the juice with the aid of heat. For use add 20 ounces of this to 40 ounces of simple sirup, and tint to required color with a raspberry coloring.—Pract. Drug.

Sarsaparilla Flavoring —

Oil wintergreen	6 drams
Oil sassafras	2 drams
Oil cassia	1½ drams
Oil clove	1½ drams
Oil anise	1½ drams
Alcohol	8 ounces

—Pract. Drug.

Skin Cream for Collapsible Tubes.—

1.	White vaseline	6 ounces
	White wax	1 ounce
	Spermaceti	5 drachms
	Sub-chloride bismuth	6 drachms
	Otto of rose	6 minims
	Oil of bitter almonds	1 minim
	Rectified spirit	½ ounce

Melt the vaseline, wax and spermaceti together, and while cooling incorporate the sub-chloride of bismuth (in warm mortar). Dissolve the oils in the alcohol, and add to the fatty mixture, stirring all until uniform and cold. In cold weather the quantities of wax and spermaceti may be reduced.

2.	Lanoline	1 ounce
	Almond oil	1 ounce
	Oleate of zinc (powder)	3 drachms
	Extract of white rose	1½ drachms
	Glycerine	2 drachms
	Rose water	2 drachms

Mix. —Pharmaceutical Era.

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